THE

ELECTRICAL REVIEW.

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ELECTRICAL REVIEW.

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CORRUPTION.

WHILE of late the Press has been fairly full of inquiries and revelations, which range from high politics and General Elections to "Bumbledom," it is surprising to note that *An Act for the better Prevention of Corruption* has been passed into law almost in silence. During its closing stages in the Commons there was very little debate, almost all of it being of a friendly character. The Bill was read a third time in the early hours of the morning—hours which seem to be reserved for legislation of a specially practical and useful character. In April last we commented at some length upon this Bill.

The only important alteration which has been made in it is that its provisions are now expressly extended to all persons serving under the Crown or under any Corporation or any Municipal Borough, County or District Council, or any Board of Guardians: this is, in our opinion, a very useful and even necessary extension.

If the Bill had been more widely known to the public we imagine that large classes of men would have found themselves wondering whether it applied to them.

Does it, for instance, cover the dustman who accepts a "small tip" for "doing or forbearing to do any act," for instance the act of removing a small heap of garden rubbish? Does it apply to the policeman who "sees a gentleman home" on a dark night?

One safeguard there is against its too ready employment in England and Ireland—that is, that the leave of the Attorney-General or Solicitor-General of the respective countries must be obtained before a prosecution can be instituted. The Act applies also to Scotland, but as they have no such officers there, we presume they must have special checks of their own before the matter comes before the Sheriff.

The Act comes into force on January 1st next. We wish it were possible to say that on that date corrupt practices would cease.

Bribery in many of its forms has for many years been punishable by fine and imprisonment. The new Act now makes it a criminal proceeding for any agent corruptly to accept or obtain, to agree to accept, or to *attempt* to obtain, any inducement or reward for doing or for abstaining from doing any act in relation to his principal's business or affairs. Thus it follows that if the letter to Messrs. Preece & Cardew, which we published on August 3rd, had been postponed until next year, its author would have been liable to an even more severe punishment than the prompt return of his tender by the eminent firm in question.

To offer or to solicit a bribe will then be a criminal act, even when the request or offer is refused. It makes the offending party equally culpable for giving or offering the bribe, which is not necessarily money, but may be valuable consideration of any kind whatever.

The punishment is fine or imprisonment. The word "agent" is defined as any person employed by or acting for another. Apparently it includes unpaid as well as paid agents. The Act is short, simple and clear, but its scope is very wide, and we strongly advise any one who contemplates doing, or attempting to do, any action which savours of bribery, or illicit profit, or commission to pause and read the Act most carefully first.

To the practice of the old hands—the bribe-giver and the bribe-taker — who know one another well, and can each trust the other absolutely, perhaps this Act will make no difference. What is one risk more to people who have taken risks for years with great profit to themselves, and who have taken them with sufficient precaution and intelligence to avoid discovery? Probably upon such men this Act will have little effect. But to young men just commencing their business careers; to nervous men afraid of making mistakes; to thoughtless men who perhaps never recognised that to be corrupt was to be criminal; to men with spite to gratify (and spite often arises among the corrupt); to discharged clerks and dismissed auditors, this Act will *not* be a dead letter. Everything now depends on the use which is made of the new law. What we desire to see, even more than many prosecutions, is the formation of a healthy public opinion.

We hope to see the time when the Act will become really a "dead letter," because of the extinction of blackmail, bribery and corruption in all their poisonous forms.

German Electrical Industry.

THE question as to the necessity for the adoption of caution in regard to the future course of the German electrical industry arises as a result of statements which appear in the reports of two Swiss companies—namely, the Zürich Bank for Electrical Enterprises and Messrs. Brown, Boveri & Co., of Baden. Why Swiss companies should deal with the Teutonic situation may best be explained by the fact that both the companies are closely associated with the General Electricity Co. of Berlin, while the bank itself is understood to represent in its annual reports the views of the general director of the Berlin company in question. With this explanation, reference may now be made to the warnings given by the bank and the other company. In the first place, emphasis is laid upon the large increase in the prices of most raw materials, especially copper, lead, tin, zinc, aluminium and india-rubber. The second point raised relates to the workmen's circumstances, as wages have everywhere undergone a material advance. Nevertheless, it is impossible to depend upon the existence of permanent peace among the workers, a fact which is proved by the movement among the metal workers, which recently threatened to involve the electrical industry in a severe conflict. A third matter is the condition of the money market. Money is dear, and the disadvantages arising from this cause, as in other trades, are also being unpleasantly noticed in the electrical industry, and will not be speedily overcome. The last point touched upon, which also renders it impossible to judge correctly the shaping of the German electrical trade, is that incidental to the increased Customs duties which have been imposed by certain other countries. These four reasons, it is considered, may either singly or in combination bring about a reaction in trade, or materially assist in doing so. At the present time there are no indications of retrogression, but it is significant that the electrical industry should be the first to raise the question. No such idea is entertained in the iron and steel trades, which are the backbone of German commercial prosperity. But should a reaction take place, the German electrical industry is in a more favourable position for meeting it than it was during the depression which commenced in 1901, the reason being the greater measure of concentration and consolidation which has been carried into effect since that period.

Railway-Motor-Car Traffic.

THE paper on this subject that was read at the Cardiff meeting of the Institution of Mechanical Engineers, by Messrs. Riches and Haslam, seems to be one that ought to have been read 20 years ago. A glance through Bradshaw will show that the branch lines of the country have for years had a very poor service, often consisting of a train of old carriages and a superannuated main line locomotive, which slept most of the day on a siding and made two or three runs to and fro at inconvenient hours. The train staff, of course, were paid for the time, so that the substitution of a light steam car run to and fro rapidly all day would not increase the wages bill, while it would certainly facilitate and increase traffic and draw people to use the line who, because of the poor service, continued to use traps on the road. But the railway managers and directors could never perceive that two or three trains per day were useless. The electric tramway has forced the facts upon them, with the somewhat belated result that the steam motor-car has come into being, and has been widely adopted in this country, as well as abroad. The authors admit that the railway companies did nothing until forced to do it by the competition of electric cars. They offer a very poor excuse indeed for the infrequent service they had run hitherto, namely, that the fewness of passengers did not warrant a frequent service with the heavy trains of antiquated rolling stock, forgetting that it was the bad service that reduced the traffic below what even a steam motor-car could deal with.

Their paper is a plea for steam cars as against electric cars, and here we think that they are very likely quite wrong. We should doubt the wisdom of a railway company which built a power house to deal with a short branch line, but having put off for so long the frequent service by light single cars, we do think they might have made use in many cases of some municipal or private source of electricity wherewith to run their branch services. To this the authors pay but scant attention, though, by electrifying some of their branch lines, they would have acquired a working knowledge of electrical traction at small cost and directly under their own supervision, if they had not, indeed, saved money as compared with steam cars.

We note that the authors speak of the water turbine in comparison with the turbines of the Metropolitan Railway, as though they thought these also were water turbines. Moreover, they comment on the "fact" that only three English electric railways transmit their power at high pressure, whereas in London alone there are five working in this way, and two more in the Provinces. We trust that this is not a fair sample of railway men's "facts" concerning electric railway working.

The mileage cost of a rail motor-car is only one-third that of an ordinary train. Why could not this have been seen 20 years ago, the train mileage trebled for trial, and the passenger service greatly augmented thereby? It should not be possible for an experienced railway man like Mr. Hurry Riches to come forward at this late hour pointing out, as though it were something newly discovered, the advantages of these new rail motors in cheapness and attraction of traffic. It was such a very simple matter to foresee all this, and the railway companies that have been forced into it might years ago have pioneered the movement with credit and profit to themselves, and to the satisfaction of the public, who, by their speedy recognition of the electrical tramcar, showed they were waiting anxiously to put money into the railway coffers, had they been allowed to do so.

EQUITABLE CHARGING FOR THE SUPPLY OF ENERGY BY MUNICIPAL ELECTRICITY UNDERTAKINGS.

By J. HORACE BOWDEN, Borough Electrical Engineer and Manager, and FRED. TAIT, Managerial Assistant, Metropolitan Borough of Poplar.

The diversity of the various demands upon electricity undertakings has made it incumbent upon those concerned in their management, to consider the present methods of charging for the supply of energy. Neither the maximum demand nor the flat rate systems approach in any degree the ideal. There are elements of equity in the former, but the complexity of its administration renders it inexpedient and generally inequitable, and whilst the latter system is simple and easily administered, it is grossly unfair to the majority of consumers. Hitherto any reduction in the price of energy by local authorities has been made by haphazard methods, particularly in the case of those who have fixed the maximum price for power at 1d. per unit. The usual course has been to reduce charges if, by overcharging the consumers or a section of the consumers, a large surplus has been realised in any year or period of successive years, but in most instances it has been an all-round reduction with no consideration whatever bestowed upon the earning qualities of each of the numerous classes of demand upon the modern power and lighting supply undertaking. A few years ago the criterion of success was the financial result of each year's trading, but, happily, most municipalities recognise the fallacy of this, a large surplus being an indication of doubtful management from a ratepayer's point of view. At the present time an undertaking is most successful by virtue of its low charges for energy supplied, but we have not yet had the opportunity of observing the financial result of what may be termed "indiscriminate charging." Much experimental work is being carried out by the commercial departments of various undertakings, and it is the opinion of the writers that the present is an opportune time for the introduction of a system for regulating charges for supply, which is at once intelligible, equitable and expedient. The tariff of charges should be fixed annually upon estimates of income and expenditure, and all balances, whether debit or credit, carried forward, and it should be the policy of the management of every municipal undertaking to provide a sufficient annual sum to adequately depreciate existing plant in order to supersede all antiquated units, and so keep up the standard of efficiency, and this sum should be included in the annual estimates and treated as a standing charge upon the undertaking. It is necessary to draw a distinction between running costs and standing charges; running costs increase with the output of the undertaking, which may or may not affect the ultimate cost per unit owing to same being entirely controlled by the plant load factor, and under this category are placed fuel, water and stores, station maintenance and distribution costs; standing charges, being those which do not materially increase with the output, are wages, rates, &c., and management charges. The latter, plus the amount of gross profit required for interest and redemption of loans, are in direct relationship to the maximum load demanded, and it is evident that every kilowatt of the maximum demand should pay an equal share of the amount required to meet these charges.

In considering an estimate of income and expenditure, the load should be divided into three general headings, viz.: —Power and heating, private lighting, and public lighting (traction being excluded entirely from this article), and the maximum load demanded divided in a similar manner, then the average price charged for each general class of supply should be as the total maximum demand is to the maximum demand for each class, so is the total of the standing charges plus running costs. For the purpose of working out an example we will assume that an undertaking with an outstanding capital of £250,000 and a plant capacity of 4,000 KW. (including overload and batteries) has a maximum demand of 2,000 KW., of which 1,000 KW. is for power, &c., 800 KW. for private lighting, and 200 KW. for public lighting, and the estimates for, say, 4¼ millions output are as follows, viz. :—

EXPENDITURE.

Running costs.		*Standing charges.*	
Fuel	0·35d.	Wages	£1,700
Water and stores ...	0·02d.	Rates, &c.	2,300
Maintenance and distribution...	0·08d.	Management	2,500
		Capital charges	12,000
		Reserve fund	2,500
	0·45d.		£21,000

INCOME.

1,000-KW. power, &c., at 30 per cent. load factor	=	2,628,000 units.
50 per cent. of standing charges ...	=	£10,500 0
2,628,000 units at 0·45d.	=	4,927 10
Average price charged = 1·4d. per B.T.U. ...		£15,427 10
800-KW. private lighting at 13½ per cent. load factor	=	946,080 units.
40 per cent. of standing charges ...	=	£8,400 0
946,080 units at 0·45d.	=	1,773 18
Average price charged = 2·58d. per B.T.U.		£10,173 18
200-KW. public lighting at 46 per cent. load factor	=	805,920 units.
10 per cent. of standing charges ...	=	£2,100 0
805,920 units at 0·45d.	=	1,511 2
Average price charged = 1·075d. per B.T.U.		£3,611 2
Total income from 4,380,000 units at 1·6d. average	=	£29,212 10

NET RESULT.

Expenditure :—4,380,000 at 0·45d. running costs =	£8,212 10
Standing charges (including reserve)	21,000 0
	£29,212 10
Income :—4,380,000 at 1·6d. average price	29,212 10
Financial result...	£0 0

From this estimate it will be seen that, allowing an ample margin for contingencies, it would be financially safe to arrange a scale of charges for each general class of load to produce an average price for power at 1½d. per unit, private lighting at 3d. per unit, and public lighting at 1½d. per unit, and any undertaking running under the conditions stated (which are favourable when compared with the majority of metropolitan undertakings) charging less than 1½d. average price for power, is doing so at the expense of private and public lighting. The writers do not wish to suggest that it is not judicious to offer a lesser rate than that stated as being equitable, in order to induce a power load, but the fact should always be borne in mind that the rate offered should not be less than that which would be profitable when the plant and mains are loaded up to the maximum, and for the purpose of ascertaining the minimum charge for power a second example is given as follows, viz. :—

3,000 KW. maximum demand (being the limit with safety to leave a 1,000-KW. set in reserve) 1,500 KW. of which is for power, &c., 1,200 KW. for private lighting and 300 KW. for public lighting. To obtain this load the capital expenditure would probably have been increased by boiler power, mains, services, meters, &c., but otherwise the standing charges would have remained practically stationary, but as a set off against this extra capital the engineer would have been enabled to run his plant at a greatly improved load factor, and although it is not within the scope of this article to discuss the effect of judicious capital expenditure on generating plant upon running costs, the writers are of opinion that, by keeping pace with all improvements out of the annual amount allowed for reserve fund, it is possible, given the load as stated, to reduce running costs in a well-equipped metropolitan undertaking to the figures as estimated :—

EXPENDITURE.

Running costs.		*Standing charges.*	
Fuel	0·21d.	Wages	£1,700
Water and stores ...	0·02d.	Rates, &c.	2,300
Maintenance and distribution...	0·07d.	Management	2,500
		Capital charges	13,000
		Reserve fund	4,500
	0·30d.		£24,000

INCOME.

1,500 KW. power, &c., at 30 per cent. load factor = 3,942,000 units.
50 per cent. of standing charges ... = £12,000 0
3,942,000 units at 0·3d. ... ... = 4,927 10
Average price charged 1·03d. per unit. ... £16,927 10

1,200 KW. private lighting, at 13½ per cent. load factor = 1,419,120 units.
40 per cent. of standing charges ... = £9.600 0
1,419,120 units at 0·3d. ... ... = 1,773 18
Average price charged 1·92d. per unit ... £11,373 18

300 KW. public lighting, at 46 per cent. load factor = 1,208,880 units.
10 per cent. of standing charges ... = £2,400 0
1,208,880 units at 0·3d. ... ... = 1,511 2
Average price charged 0·776d. £3,911 2

Total income from 6,570,000 units at 1·145d. average = £32,212 10s.

NET RESULT.

Expenditure, 6,570,000 units at 0·3d. running costs ... ... = £8,212 10
Standing charges (including reserve) 24,000 0
£32,212 10
Income, 6,570,000 units at 1·145d. average... ... 32,212 10
Financial result ... ... £ 0 0

Allowing for contingencies, a scale of charges producing the following average prices would amply suffice to meet our requirements, viz.:—Power, &c., 1·05d.; private lighting, 2d.; and public lighting, 0·8d.

By the foregoing statements it is indisputably proved that a flat rate of 1d. per unit for power, &c., is not equitable, as either or both the public and private lighting consumers must suffer by it, and the writers submit that the following system for charging for power is just, simple and expedient. Assuming that it is found from the records of the undertaking that the maximum demand for power is 30 per cent. of the motors connected, the KW. capacity of the latter where 1,500 KW. is demanded would be about 5,000 KW., and the amount required for standing charges is £12,000, the rate of charge should consequently be, say, 50s. per KW. installed, and ·3d. per unit consumed. The justice of this charge is upheld when it is considered that each consumer has the right to demand up to the full capacity of his installation, and provision must be made in station and on mains for this demand at all times. Should a consumer find that his installation exceeds his requirements, he would be entitled to have the surplus amount disconnected.

Public lighting having no diversity factor stands, of course, at the amount worked out—viz., 0·8d.

Private lighting generally presents a much greater difficulty in fixing an equitable scale of charges, therefore a low flat rate should not be instituted, as it is grossly unfair for the long-hour consumer to pay for the consumer who only uses the supply for an infinitesimal period. It is quite practicable to fix a stated charge per unit according to a tariff based on a declaration of business hours when application is made for connection, and the writers have worked out the scale of burning hours (see bottom of previous column) from the time of lighting up public lamps to a declared hour of closing.

The following tariff of charges is compiled from both estimates taken as examples in this article :—

TARIFF OF PRIVATE LIGHTING CHARGES.

Hours consumer.	Load factor.	Annual hours consumption.	First estimate.			Second estimate.		
			Standing charges at £10 10s. per KW. max. dem.	Running cost.	Charge to consumer.	Standing charges at £8 per KW. of max. dem.	Running cost.	Charge to consumer.
			Pence.	Pence.	Pence.	Pence.	Pnce	Pence.
¼	1·04	91	27·70	·45	28·15	21·04	·3	21·34
½	2·08	182	13·85	·45	14·30	10·52	·3	10·82
¾	3·12	274	9·20	·45	9·65	7·81	·3	8·11
1	4·16	365	6·90	·45	7·35	5·26	·3	5·56
1½	6¼	548	4·60	·45	5 05	3·90	·3	4·20
2	8⅓	730	3·45	·45	3·90	2·63	·3	2·93
2½	10·42	912	2·76	·45	3·21	2·10	·3	2·40
3	12½	1,095	2·30	·45	2·75	1·95	·3	2·25
3½	14·6	1,278	1·98	·45	2·43	1·50	·3	1 80
4	16·7	1,460	1·73	·45	2·18	1·32	·3	1·62
4½	18¾	1,642	1·54	·45	1·99	1·17	·3	1·47
5	20⅚	1,825	1·38	·45	1·83	1·05	·3	1 35
5½	22·9	2,008	1·26	·45	1·71	·96	·3	1·26
6	25	2,190	1·15	·45	1·60	·88	·3	1·18
6½	27·1	2,372	1·06	·45	1·51	·81	·3	1·11
7	29·16	2,555	·99	·45	1·44	·75	·3	1·05
7½	31¼	2,738	·92	·45	1·37	·70	·3	1·00
8	33⅓	2,920	·86	·45	1·31	·66	·3	·96
8½	35½	3,102	·81	·45	1·26	·62	·3	·92
9	37½	3,285	·77	·45	1·22	·58	·3	·88
10	41·7	3,650	·69	·45	1·14	·53	·3	·83
11	45·8	4,015	·63	·45	1·08	·48	·3	·78
12	50	4,380	·58	·45	1·03	·44	·3	·74
13	54·16	4,745	·53	·45	·98	·40	·3	·70
14	58⅓	5,110	·49	·45	·94	·38	·3	·68
15	62½	5,475	·46	·45	·91	·35	·3	·65
16	66·7	5,840	·43	·45	·88	·33	·3	·63
20	83⅓	7,300	·35	·45	·80	·26	·3	·56
24	100	8,760	·29	·45	·74	·22	·3	·52

From the foregoing statement it is apparent that an absolutely equitable scale of charges for private lighting is impossible, as the charges to short-hour consumers, even if fixed at the maximum rate allowed by the Electric Lighting Acts, viz., 8d. per unit, fall far short of the actual cost to an undertaking, and the charge to the ¼-hour consumers, among whom may be classed proprietors of schools, banks, offices, and all business premises closing at 5.30 p.m., to be strictly just should be not less than 2s. 4d. per unit in the first instance, and 1s. 9d. per unit in the second. As, however, it is not expedient in the interests of the undertaking to prohibit the supply to any class of consumer by charging 8d. per unit, it would be judicious to class all consumers up to 7 p.m. as 1-hour consumers (taking the second example as a basis) at a charge of 5d. per unit, 8 p.m. = 1½ hours at 4d., 8.30 p.m. = 2 hours at 3d., 9 p.m. = 2½ hours at 2½d., 10.30 p.m. = 3½ hours at 2d., and 12.30 a.m. = 6½ hours at 1¼d.

Private house lighting can generally be assumed at 4½ hours equal to a 1½d. rate.

Of course, these rates are all based on very low costs, which to many may appear impossible, but the writers are of opinion, justified by facts, that such results will be obtained in the immediate future; but no matter what the costs may be, the system that they have endeavoured to demonstrate is applicable to any undertaking, and is preferable to the maximum demand and flat rate systems at present in vogue. If generally adopted, it will do much to popularise the distribution of a natural force eminently adapted for the service of mankind, that should be available to every citizen at the cost of production only, and the lowest possible cost at that, without the necessity of paying toll to any company or companies of monopolists.

EVENING BURNING HOURS. 365 DAYS PER ANNUM.

Lighting up time to :—	Annual burning hours.		Average daily hours at 7 days per week.	Average daily hours at 6 days per week.	Average daily hours at 5 days per week.
p.m.	Hours.	Min.	Hours.	Hours.	Hours.
4.0	18	19	0·05	0·043	0·036
5.0	115	18	0·316	0·271	0·226
5.30	186	56	0·512	0·439	0·366
6.0	273	18	0·749	0·642	0·535
6.30	375	5	1·03	0·883	0·736
7.0	492	41	1·35	1·157	0·964
7.30	626	57	1·72	1·474	1·230
8.0	781	19	2·14	1·834	1·53
8.30	962	18	2·64	2·263	1·886
9.0	1,144	48	3·14	2·691	2·243
9.30	1,327	18	3·64	3·12	2·60
10.0	1,509	48	4·14	3·55	2·957
10.30	1,692	18	4·64	3·98	3·314
11.0	1,874	48	5·14	4·406	3·67
11.30	2,057	18	5·64	4 834	4·03
12.0	2,239	48	6·14	5·263	4·386
12.30	2,422	18	6·64	5·69	4·743

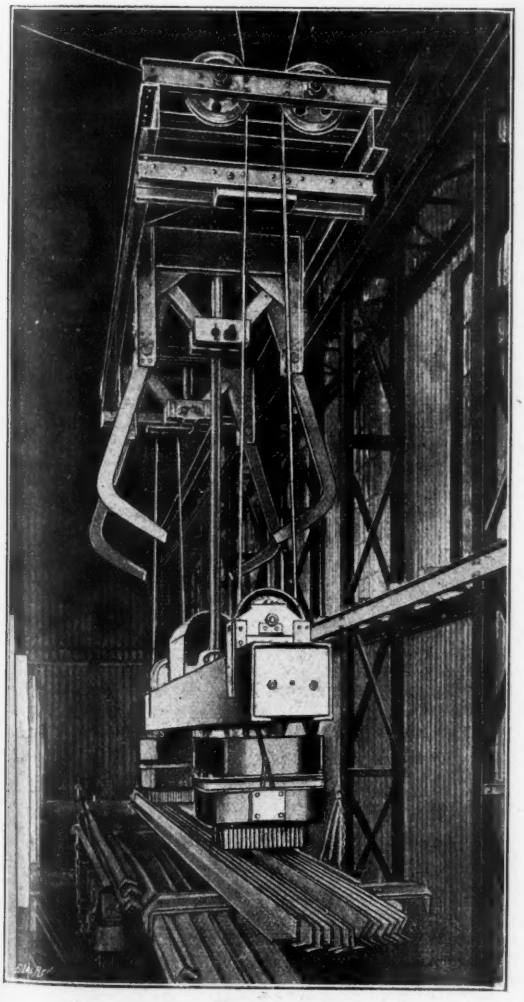
Shildon Tramways.—The B. of T. has informed the U.D.C. that an extension of time until August 15th, 1907, has been granted for the completion of the Bishop Auckland, Shildon and Spennymoor tramways.

ELECTRO-MAGNETIC TRAVELLING CRANE FOR THE LOADING OF BAR-IRON.

By Dr. ALFRED GRADENWITZ.

A travelling crane recently constructed by the Vereinigte Maschinenfabrik Augsburg und Maschinenbaugesellschaft Nürnberg A.G., contains an ingenious electro-magnetic grip (Stuckenholz patent), specially arranged for the sorting, storing and loading of bar-iron.

A crab carrying the lifting gear, crab-travelling gear and driver's cage runs on the main girders of the crane, covering a space 13 m. in breadth, and a transverse beam supporting two lifting magnets is suspended from the wire ropes of the two hoisting drums. As bars of all lengths up to 12 m. must be handled by the lifting magnets, these are provided with rollers, free to run on the transverse beam, and are traversed by an electro-motor placed on the beam and controlled from the driver's cabin. After being lowered to the bar-iron to be lifted, the magnets are energised and hold the bars; the transverse beam with the lifting magnets and the iron bars is then raised until the safety bows, attached to a frame hanging above the transverse beam, automatically clip the bars. This obviates any possibility of the latter being dropped during the subsequent conveyance to their destination, even in the case of a sudden interruption of

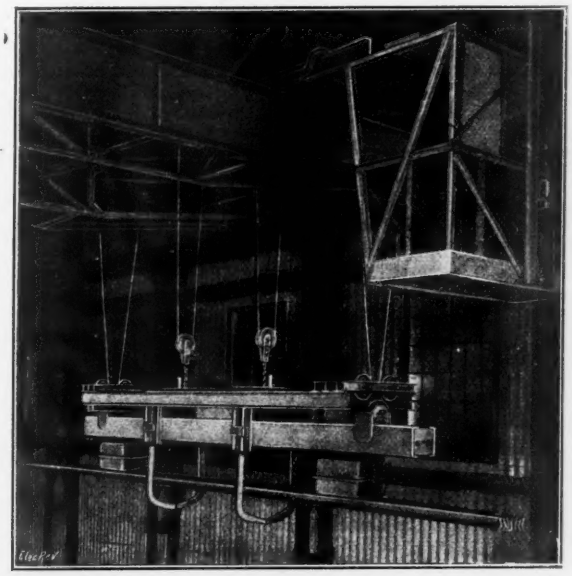


Crane about to Lift Iron Bars.

the current or an accidental shock, and thus affords perfect safety in operation.

The magnets can be energised to any degree, according to requirements, for lifting a smaller number of bars, or releasing the latter one by one. The capacity of the two magnets is 2,000 kg. as a maximum in the case of bar-iron. Arrangements are provided for working with one magnet only, when the maximum capacity is 1,000 kg.

The frame to which the safety bows are attached is suspended from wire ropes, the drums of which are put into connection with the lifting gear on closing the bows, so as to cause the beam and frame to move up and down together. Special motors have been provided to actuate the hoisting and crab-travelling gears as well as the displacement of the magnets, all the motions being controlled from the driver's cabin, and the driver is in a position always to inspect the



Crane Carrying a Load of Bar-iron.

load. The working speeds per minute are:—15 m. in lifting; 45 m. in traversing the crab; 100 m. in travelling.

The magnet switches and lifting-gear controller are operated by what is called a universal steering gear, a similar steering device being provided for the crane and crab-travelling-gears, thus effecting the whole operation of the crane by the aid of only two steering levers. Alternating current at 400 volts pressure is used for operating the crane, and is converted into direct current, at 230 volts pressure, by means of a transformer, for use in connection with the lifting magnets. The energy is supplied from the crane to the magnets, as well as to their driving motor, through a flexible cable, which is automatically drawn out on lowering and wound up on hoisting.

An obvious advantage of such cranes is that the suspension of the load by chain slings is done away with, while the load may be taken off without supporting pieces, which are indispensable in the case of chains. This affords a considerable saving of time and labour, while utilising the space available in a workshop to the best advantage and with the highest economy.

THE WAYS OF STEAM TURBINES.

[communicated.]

Those engineers who have had actual experience of the running and maintenance of steam turbines are well aware that this type of prime mover possesses many peculiar characteristics, which distinguish it from other types. The writer ventures to think that the enumeration of a few of these will prove of general interest.

It may be safely stated that turbines can easily hold their own with steam engines of any type as regards governing, and where a large varying load is to be taken care of, the turbine holds an emphatic advantage. In spite of this, makers are constantly receiving complaints from resident engineers, &c., to the effect that the speed (and, conse-

quently, voltage) variation is greater than the specified contract allowance. *A propos* of this, a simple fact may be noted which, in the writer's estimation, has a very potential bearing on the question. Assume two or three steam turbines of the Parsons type—*i.e.*, with the pulsating poppet valve, to be running in parallel on a varying load. Now, if the beating valves on all the machines are in synchronism, all the up and down strokes being made simultaneously, a surprising difference in the variation recorded under these conditions will be noted from the greater variation recorded when the valves are all beating at indiscriminate times. A simple yet important fact to note.

How many of our station engineers realise the great risk they take each time a condensing turbine is suddenly thrown over to atmosphere, owing, perhaps, to loss of circulating water or breakdown of an air pump. Yet one constantly sees shift engineers take these occurrences with the greatest possible sangfroid. The point to note is this :—When a large turbine is suddenly changed from exhausting into a condenser to exhausting into the atmosphere an actual and visible displacement occurs. The extent and direction of the movement depends, of course, upon the conditions prevalent at the moment, or better still, perhaps, upon the extent of the change of conditions. The results also are many, and at present somewhat wrapped in mystery. Assuming, then, that the only consequence is a sudden "whip" of the revolving spindle, causing the blades to rub on the cylinder walls for a time, we are at once up against a condition sometimes attended with disaster. Most turbine blades are bound with metal strip and copper wire a short distance from their periphery, and the effect of this rubbing is to raise the temperature of the blade ends sufficiently high enough to cause "hot-short." After this has once occurred, it needs little else to break off the ends of the blades, and a whole or partial strip almost inevitably follows.

Boiler sediment, of any kind, when passed over with steam, is a continual source of worry to engineers who come into contact with it. The writer had the opportunity, some time since, of inspecting a turbine, the blades of which had been indirectly affected to a great extent by such sediment, the result being both interesting and novel. The low pressure cylinder blade areas of this particular machine had gradually become almost choked up with a brown chalky sediment. The steam, in passing through the restricted passages, had been wire-drawn and re-superheated to such an extent as to wear the sharp steam edge of the blades completely away ; and this, in conjunction with the deposited sediment, greatly reduced the efficiency of the turbine. Several of the blades in the final rows had become so small in cross-section, that a touch would almost break them off. Of course, this proved to be an extremely expensive method of preventing a deposit in the boilers themselves, and one such experience (it was found to be necessary to re-blade the whole low pressure end of the turbine), was sufficient for the individuals concerned, to prevent any repetition of such a happening.

Some few weeks since the writer paid a visit to one of our largest generating stations, and while there was an interested spectator during one of those exciting periods which at some time or other inevitably occur in such places.

It happened during the time, when, owing to a comparatively light load, several units (large turbo-generators of about 6,000-KW. capacity) were temporarily shut down.

Suddenly, without any previous warning, an abnormally heavy load came on, which it was seen the machines running were totally incapable of dealing with, albeit the automatic by-pass valves were full open, and the steam pressure well up to normal working conditions. The immediate consequence was a quick drop in speed of all the machines, which were at the time running in parallel. This drop began to take place just at the moment the engineer had got the spare unit up to full speed. Seeing the state of affairs, he (the shift engineer) at once closed the stop valve of the spare unit, with the intention of bringing it down to synchronising speed. The machines on load, however, were falling in speed much more rapidly than the spare, although every steam valve on the latter was jammed down hard. The speed, and consequently voltage, eventually reached such a low point that the oil, circulating, and air pumps stopped running. At this critical juncture the resident engineer, who, with every other engineer, had been running about in frantic endeavour to set matters right, ordered a portion of the load to be switched off. Even after this had been done, it took several hours to regain normal speed, owing to the great difficulty experienced in getting the condenser circulating water pumps to run at a sufficiently high speed to maintain the necessary head of water in the condensers required to hold a respectable vacuum.

Of course, had the shift engineer paralleled the spare machine earlier than when he made the futile attempt, the above trouble would have been obviated.

On the other hand, the sudden load in this case was quite unprecedented at that particular time of the day, and if it had been possible by any means to reduce quickly the speed of the turbine they were trying to parallel, after the fall in revolutions of the other units, this would again have prevented such a *contretemps*.

The moral one naturally deduces from such an occurrence as the foregoing is that turbines should have brakes. But these latter undoubtedly have very many disadvantages in their application ; and it was the intention of the writer solely to relate what to many would have been an interesting and exciting scene, rather than to introduce a subject of such controversial capacity as "Ought steam turbines to be equipped with brakes ? "

Steam turbines are, after all, a comparatively new "species" of engine, and many of their idiosyncrasies have yet to be familiarised to us. Statements, therefore, of the foregoing nature, cannot but prove to be of interest to those young engineers who, up to the present have had neither the opportunity nor experience, which alone reveal such traits in the behaviour of a machine.

THE ELECTRICAL FROISSART CHRONICLES.

(With some apologies to Sir John, and more to "F. C. G.")

By IBID.

VIII.—The Worship of the Diplodoccus.

The mind of man (if he hath any) is moved in spring-time to many curious devices ; some will away to Mars-gate or to yet more distant countries, to sacrifice to their symptoms ; others rejoice at the return of the sun with making of fires and strange noises and coloured lights, and other Kimmikals ; and many make offering and do worship unto their ladies, especially those who are slow in returning from labour. So also the Electriks hold a feast or Ceremonie, to which are bidden not only the Outer and the Inner Circle, but the Middlemen also, and ambassadors from strange countries ; so that all come together in amity and fine raiment, at least for the time being.

That festival is holden on this wise. First, be it known to you that in the far West is situate a great palace of the Terra Cotta period, which extendeth about half a mile each way ; and this was doubtless built for some-one, but is now (at least in part) given over to the bats and owls by reason of the cab-fare. Nevertheless, it is at the one end a very fair castle, and kept in marvellous good order ; and therein many wonders are to be seen, such as are spoken of by Sir John Manndeville and other learned and precise chroniclers. I am told that it is properly called "The House of the Bones of our Ancestors" ; and, in sooth, therein is a noble statue of the High Priest of that cult, who first maintained that before ever man was he had poor relations waiting for him.

The meeting of the Electriks is on this fashion ; all, little and great, arrive as they may, with an air of due solemnity, in the portal ; and, being formed in line, are hospitably welcomed by the good precedent, and other of their chief people ; which being done, they are free to examine the place and all therein, and to refresh themselves with the cates provided. There is also music, the which stimulateth conversation ; and many fair dames attend that meeting, and sith there is no jousting or tilting at the ring or other

decorous and seemly display they will not faint for excitement.

The most part do parade them solemnly through an inner chamber or hall, wherein is a great image, of the likeness of a skeleton, very curiously made, which all regard with awe and respect, and having so done, move out again. Thereafter remaineth no more to be done, for that it is not seemly to bring catalogues; and so doth everyone in turn, without undue haste, betake himself to his hostelry.

Now, in explanation of this their ceremonie, it is told to me that that image or skeleton is the symbol of success, before which even the Electriks must sacrifice like the rest. Seeing that the idol is endowed with a neck practically unlimited and a cerebral cavity small in comparison, it may well be so. Others, however, say that it is the first example of long-distance transmission of power. Wise is the man who sees the true significance of it, for the true magician is distinguished by the simplicity of his acts; so that he compasseth a very great effect without showing the cause.

LIMITATIONS OF THREE-WIRE ENERGY MOTOR-METERS.

By H. G. SOLOMON.

The measurement of the electrical energy supplied to a three-wire network is readily effected by treating each half of the system as an independent two-wire circuit, in each of which a two-wire energy meter is used. Each meter is connected to its half of the three-wire system by placing its main current circuit in the corresponding outer conductor, and its pressure circuit between this conductor and the neutral main. Instead, however, of two meters, a single three-wire energy meter is very often employed, and the object of the present article is to show that the ordinary three-wire energy motor-meter correctly measures the energy consumption under certain conditions only. The results obtained vary with the nature of the supply current, so that it is necessary to consider separately the behaviour of three-wire energy motor-meters when a direct-current supply is used, and when the system is fed with alternating current.

Incidentally, it may be of interest to point out that the Aron three-wire clock meter always correctly measures the energy absorbed in such a system, whether fed with continuous or alternating current, however unbalanced the two sides may be, and whatever phase displacements may exist between the currents and the three-wire voltage when the supply is an alternating-current one. The meter, in fact, consists of two distinct meters, each of which has a stationary main current coil and a pendulum volt coil operating together. The two main current coils are inserted in the two outer conductors, one in each, and the two volt coils on the pendulums are placed in series across the three-wire network, with their junction connected to the neutral wire.

Continuous-Current System.

In a continuous-current system the three-wire energy motor-meter, such as the Thomson type, has two stationary main current coils and one armature circuit, the latter comprising the armature proper, the high resistance coil, and the compound winding, all of which are in series with one another. The meter, having only one pressure circuit, is therefore not a combination of two motor-meter elements; and it is for this reason that it does not always function correctly.

The one main current coil is placed in series with the positive conductor, and the other in series with the negative main, and the armature circuit is energised by a current proportional either to the total three-wire voltage or to the pressure between the neutral wire and one of the outer conductors. The rotation of the armature is due to the interaction of the pressure current flowing in it with the main current flux created by the currents in the two stationary coils.

When the three-wire system is in balance, *i.e.*, when there is no out-of-balance current in the neutral wire, and also when the two branches are unequally loaded but the pressures between them are maintained equal to one another, the ordinary three-wire energy motor-meter, assuming that it has no errors, will correctly measure the true energy absorbed, however its pressure circuit may be energised. When the system is unbalanced, the meter will always register incorrectly, and the degree of inaccuracy will depend on the method of connection of the armature circuit. If the latter be energised by the total three-wire voltage, the meter will read high, and the errors will be small. If, on the other hand, it be connected between one of the outer mains and the neutral wire, the meter will read high or low according as the voltage across the armature circuit is high or low, and the errors will be considerably greater than in the former case. These results may be readily established in the following manner:—

If v_1 denote the pressure between the + outer and the neutral conductor, v_2 the pressure between the latter and the − outer main, and c_1 and c_2 denote respectively the currents in the positive and negative outers, v being the total three-wire voltage, such that $v = v_1 + v_2$, the energy consumed in the interval $t_2 - t_1$ is—

$$E = \int_{t_1}^{t_2} v_1 c_1 \, dt + \int_{t_1}^{t_2} v_2 c_2 \, dt. \qquad (1)$$

When both sides of the system are equally loaded, $v_1 = v_2 = \frac{1}{2} v$, and $c_1 = c_2 = c$ (say), and the energy becomes

$$E = 2\int_{t_1}^{t_2} v_1 c_1 \, dt$$

$$= 2\int_{t_1}^{t_2} v_2 c_2 \, dt$$

$$= \int_{t_1}^{t_2} v c \, dt.$$

Case 1.—The armature circuit of the meter is connected direct across the outers of the three-wire system, *i.e.*, it is energised by the total three-wire voltage v.

The energy given by the meter is

$$\tfrac{1}{2}\int_{t_1}^{t_2} v (c_1 + c_2) \, dt.$$

The true energy absorbed is given by Equation (1), which can be expressed in the form

$$E = \tfrac{1}{2}\int_{t_1}^{t_2} v (c_1 + c_2) \, dt$$

$$+ \tfrac{1}{2}\int_{t_1}^{t_2} (v_1 - v_2) c_1 \, dt - \tfrac{1}{2}\int_{t_1}^{t_2} (v_1 - v_2) c_2 \, dt. \qquad (2)$$

When the system is in perfect balance, and also when the currents c_1 and c_2 are unequal, but $v_1 - v_2$ is zero, the terms

$$\tfrac{1}{2}\int_{t_1}^{t_2} (v_1 - v_2) c_1 \, dt \text{ and } \tfrac{1}{2}\int_{t_1}^{t_2} (v_1 - v_2) c_2 \, dt$$

will vanish, and it will be seen that the meter will register correctly. If, however, the two branches be unequally loaded, *i.e.*, if c_1 and c_2 be unequal and also v_1 and v_2, unequal the energy given by the meter, connected in the manner explained, will always be greater than that actually supplied, both when c_2 is greater than c_1, as then $v_1 - v_2$ is positive, and when c_2 is less than c_1, as then $v_1 - v_2$ is negative, so that the error is always of the same sign.

Case 2.—The armature circuit of the meter is connected between one of the outer conductors and the neutral wire, *i.e.*, it is energised by the voltage v_1 (say).

The energy given by the meter is

$$\int_{t_1}^{t_2} v_1 (c_1 + c_2) \, dt.$$

The true energy is, from (1),

$$E = \int_{t_1}^{t_2} v_1 (c_1 + c_2) \, dt - \int_{t_1}^{t_2} c_2 (v_1 - v_2) \, dt. \qquad (3)$$

As in Case 1 when the system is balanced, and also when an out-of-balance current exists, but $v_1 - v_2 = 0$, the term

$$\int c_2 (v_1 - v_2) \, dt$$

vanishes, and the meter registers correctly. When the two sides of the network are unequally loaded, the meter will again register wrongly, and will read high or low according as the voltage across the armature circuit is higher or lower than that across the other half of the system.

Suppose that the voltage v_1, the pressure used, is higher than the pressure across the other side, then $v_1 - v_2$ is positive, and the energy given by the meter is greater than the true energy, as will be seen from Equation (3). If, however, v_1 be less than v_2, then $v_1 - v_2$ is negative, and the meter will read low. Hence the errors are not always of the same sign, and are greater with this method of connection than when the armature circuit is energised by the total three-wire voltage.

In the following three tables the percentage errors of continuous-current energy motor-meters, corresponding to the above cases, are given for three out-of-balance currents, each of which is expressed as a percentage of the greater of the two currents in the outer conductors, and for differences of pressure between the two sides of the system expressed as percentages of the total three-wire voltage.

Table A.—Armature Circuit of Meter Connected Across the Outer Conductors of the Three-wire System, *i.e.*, Energised by the Total Three-Wire Voltage.

Difference of pressure between the two sides expressed as percentage of the total three-wire voltage.	Percentage error.		
	10 per cent. out-of-balance current.	15 per cent. out-of-balance current.	20 per cent. out-of-balance current.
0	0	0	0
1	0·053	0·081	0·111
2½	0·132	0·203	0·278
5	0·264	0·407	0·559
10	0·529	0·817	1·123
15	0·796	1·229	1·695
20	1·064	1·648	2·272

Note.—The meter reads high.

Table B.—Armature Circuit of Meter Connected Between the Neutral Main and One of the Outer Conductors, and Energised by the Greater of the Two Voltages.

Difference of pressure between the two sides expressed as percentage of the total three-wire voltage.	Percentage error.		
	10 per cent. out-of-balance current.	15 per cent. out-of-balance current.	20 per cent. out-of-balance current.
0	0	0	0
1	1·053	1·090	1·112
2½	2·635	2·708	2·785
5	5·277	5·427	5·586
10	10·582	10·899	11·236
15	15·915	16·415	16·949
20	21·276	21·978	22·727

Note.—The meter reads high.

Table C.—Armature Circuit of Meter Connected Between the Neutral and One of the Two Outer Conductors, and Energised by the Smaller of the Two Voltages.

Difference of pressure between the two sides expressed as percentage of the total three-wire voltage.	Percentage error.		
	10 per cent. out-of-balance current.	15 per cent. out-of-balance current.	20 per cent. out-of-balance current.
0	0	0	0
1	0·948	0·920	0·889
2½	2·371	2·308	2·229
5	4·749	4·613	4·469
10	9·523	9·264	8·988
15	14·323	13·953	13·559
20	19·149	18·681	18·181

Note.—The meter reads low.

(*To be concluded.*)

PRACTICAL NOTES ON UNDERGROUND SUB-STATIONS.

By W. PLEASANCE.

The evolution of a distributing system for alternating currents usually proceeds along the lines of substituting for isolated transformers in street-tanks, a concentration of similar transformers of larger capacity in suitably-situated sub-stations. Unless the supply scheme is originally laid out with a view to ultimate large demands, transformer sub-stations, being only necessary when a system is extending or increasing in output, are usually designed and constructed by the staff actually in charge of the operation of the mains. The design and construction of sub-stations is therefore a subject which is particularly interesting to mains superintendents and distributing engineers connected with power supply undertakings, from the fact that such work, while falling within the limits of their ordinary duties, can be undertaken in such a variety of ways, and presents so many interesting engineering problems. In the following notes the writer does not intend to go further than the consideration of the general design of underground chambers for static transformers and their accompanying switchgear. The design of an above-ground sub-station for static transformers is only a matter of space and expense, the chief point to be observed being that the sub-station must be at least as safe to work in as the switchboard gallery at the generating station. The building of a sub-station for rotary transformers involves special features which require separate treatment.

The point at which a system will be financially profited by the substitution of sub-stations for the street tank system depends not only on a consideration of the losses in small isolated transformers and low-tension runs, compared with those in larger transformers feeding into relatively longer low-tension distributors, but also upon the amount of initial capital thrown away in the reconstructing process, and the fresh expenditure involved in excavating, building and equipping the new sub-station. Such considerations often delay the substitution long after it has become advantageous from an engineering point of view, and the countervailing arguments of increased ease and safety of working are of but small potency with a dividend-loving directorate. Even when the necessary financial support has been obtained, purely scientific reasoning will not have full play. Theoretically, the district should be cut up into a convenient number of sections of such size that the estimated load for the succeeding two or three years will be approximately equal in each section. Then the "centre of gravity" of the load in each district, or the point from which the demand can be supplied with the minimum amount of low-tension copper, should be found, and the sub-station planted at that point, high-tension feeders being led to it from the generating station, and preferably link cables being laid between the different sub-stations, while low-tension feeders should tap on to the network at suitable sectional "centres of gravity" of load. Unfortunately, on a transformation scheme there is rarely enough money available to enable the engineer to abandon the whole of his original and imperfect system in favour of a brand-new one guaranteed to be theoretically the most efficient for three years' development of load. The man in charge of the conversion must mark on his map the present position and size of all low and high tension feeders and distributors; and the design evolves into a compromise between the above-mentioned theoretical considerations, and the minimum alteration necessary to existing arrangements.

Certain practical points are shown by experience to be factors in the choice of position. In underground transformer chambers the chief enemy is water. When the rains descend and the floods come and beat upon the road without a slope, the gulleys are probably choked with leaves and other *débris*. Should there be a transformer chamber in that road having a ventilator flush with the pavement, or a manhole cover that is not impervious to moisture, that transformer chamber will form itself into a convenient sump for a large body of water. The writer knows of one case where an observant policeman, standing in

a wet street after a miserable day, noticed that a cover in the road was quite dry. Rightly considering this to be somewhat in the nature of a miracle, he crossed over, stooped, and felt the framework. The overheated condition of the portion of his hand in contact with the iron induced the policeman to come to the conclusion that electricity was at the bottom of it, and he rang up the works. A mains assistant on arrival found that he had located a big secondary earth that had puzzled them for an hour or so. The cover, having had its bolts removed, lifted itself

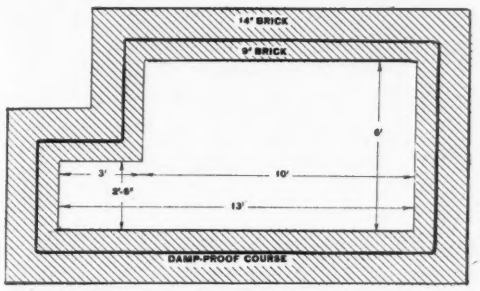


Fig. 1.—Plan of Chamber.

from its seat without further assistance; inside was a cauldron of bubbling water; the bitumen was reduced to a nasty-looking pulp, and the low-tension contacts were ruined.

It is necessary, therefore, to build a transformer chamber, if possible, in a sloping street, however slight the slope may be, so that good drainage may be secured. For the same reason the fronts of fishmongers' shops should be avoided, as the constant washing down of counters causes water to flow continually over the chamber cover, carrying with it dirt and scales, which eventually stop the drainage.

Another point to be carefully considered is that the covers have occasionally to be lifted and kept off some time, while men are working in the chamber. It is imperative that the absence of these covers shall not interfere with foot traffic or cause inconvenience to the occupants of adjoining property, who would, in such case, be able to establish a claim against the supply company. For this reason the chamber cover should not be situated in a private cartway or narrow roadway; and while it is generally preferable to have the chamber entrance on the footway, it must not occupy a narrow part of the path.

The size of the chamber will be, of course, the smallest compatible with the space required by the switchgear and with the number and size of the largest transformers likely to be used. As a measure of precaution against possible flooding of the chamber, it is best to use the type of transformer designed to be placed within a watertight tank, which is bulkier than the unenclosed type for the same output because of its greater heat-retaining capacity. The size of the chamber should therefore be sufficient for this increased bulk. Two types of construction are in use—the single-chamber type, in which transformers and switchgear are placed in the same chamber, and the double-chamber type, in which the switchgear is placed in one chamber, the transformers in a pit separated from the switchgear chamber by a wall. In the former case the chamber cover is made large enough to admit the largest transformer in use, and is provided with a smaller opening for a light manhole cover for use on inspectional visits. This point will be more fully referred to later. In the latter case, two separate openings from the pavement are provided—one for the switch chamber, the other for the transformer pit. The point which it is desired to emphasise at present is that in the single-chamber type the size of the chamber must be increased by the width of a clear gangway, which must be left past the transformers and switchgear, so that any transformer in the chamber may be moved to a position directly under the cover preparatory to lifting out. In the double-chamber type there is probably not so great a distance to traverse, as the cover is directly over the transformers, and the transformer pit need only be large enough to hold the plant that would take the load within the assigned area with a reasonable voltage drop. As regards the depth of excavation, the chamber when finished should have a clear depth inside of 7 ft. from floor to ceiling.

The prime essential of an underground sub-station is that it shall resist water under pressure. In some situations—as, for example, when the land in which the station is situated is below the level of an adjacent river or canal—the pressure of water is very great. The difficulty of perfect waterproofing is so pronounced that some engineers of great experience in this work have faith only in iron tanks well jointed, caulked, and painted to stop the intrusion. This construction, however, although efficacious, is too expensive for universal adoption, and a brick-and-concrete structure is generally used. The waterproofing adopted depends on the nature of the soil in which the chamber is placed. In very wet situations, the walls and floor are constructed in two shells, one enveloping the other, the shells being separated by a damp-proof lining of asphalt or other bituminous mixture, or felting impregnated with bitumen. In drier situations a course of cement and sand may take the place of the damp-proof lining, while in some dry situations a simple brick-and-concrete structure can be used.

There is a rule framed by the Board of Trade which is honoured by some designers more in the breach than in its observance. This is, that every sub-station containing high-tension gear should have a means of entrance which will enable a man, on entering the chamber, to descend into a space entirely free from all gear or danger of contact therewith, in order that he may look round before proceeding any further. This is best fulfilled by making a recess in one side of the chamber, as shown for different types of chamber in fig. 1. The frame and cover is placed over this recess. In the double-chamber type the side of the recess is fitted with a Jacob's ladder, the steps being cemented into the wall. In the single-chamber type the recess is made large enough to accommodate one transformer, in order that these may be lifted in and out, and the Jacob's ladder is replaced by a light movable iron ladder.

The excavation having been made, the first step in the construction of a brick and concrete chamber is the laying of the floor. Concrete of not more than three to one of good washed gravel and Portland cement should be laid to a depth of about 9 in. This floor should have a slight fall—say, 1 in. in 3 or 4 ft.—towards a small sump, which should preferably be situated underneath the manhole, and provided with trenches running the length of the chamber, so that any water percolating into the chamber may be collected at once in the sump, to be baled or pumped out at the visit of the attendant. The depth of 9 in. should be

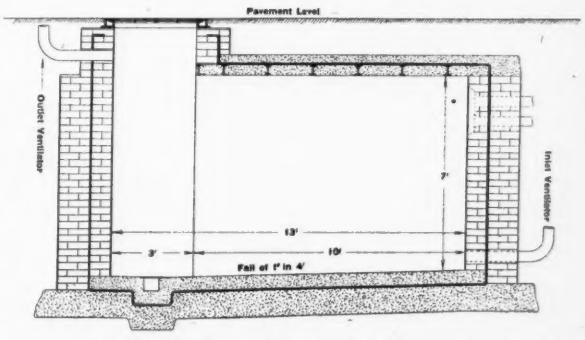


Fig. 2.—Vertical Section of Chamber.

maintained throughout. On this floor is built the outer shell-wall of, say, 14-in. brickwork. These walls being complete, the damp-proof course is laid on the floor and up the sides of the wall. When this consists of bitumenised sheeting the joints are made with a hot iron; if asphalt or asphaltic compound is used, it is applied hot and ironed to a uniform thickness; if lead sheet is used, the sheets should be "wiped" together. Where damp-proof sheets are used, provision must be made whereby the course may be taken, without any crack or hole which will admit water, right over the roof. For this purpose the sheets must be carried up the walls above the roof level, and allowed to flap back till the inner roof is fixed, when they can be bent down over the roof. Where gaps occur in the roof for manholes the damp-proof course is carried up and laid under the last course of brickwork. Too much stress cannot be

laid on the necessity for absolute continuity of this damp-course in order to render it of any service whatever. In applying such a damp-proof course, the British workman must be the object of careful supervision. His motives are usually of the best, but he has no idea of the power of water pressure. He will, for example, in putting up water-proof sheeting, tack it up to the wall with nails in order to get it to hang well preparatory to ironing the sheets together. On being questioned as to how he is going to stop up the nail-holes he is dumb.

On the top of the damp-proof course, the second floor can now be laid, of concrete 3 in. deep, in which the trenches and sump are again made, and a 9-in. inner brick wall is built up. On this inner wall the girders to carry the roof are laid. For ordinary sized chambers laid under footpaths 4½-in. H girders pitched 20 in. apart are amply strong enough, the intervening spaces being filled in with good concrete. For roadways the girders must be heavier, having regard both to the loads they will carry, and their length of span. They should be regarded as a bridge carrying a concentrated live load, such as a wheel of a cart. In a main road, traction engines and other heavy traffic must be allowed for. The inner roofing being complete, the damp-course must be brought over it, and finally a protecting cover of concrete of 3 in. depth should be added before the pavement is reached.

The position of the cable ducts to the chambers should be designed, not only in relation to the best arrangement in the road, but also to the convenient grouping of the cables on the switchboards. Nothing is more unsightly or dangerous than a nest of inter-crossing cables cumbering up the confined space of an underground sub-station. It is usually possible to find a way of leading the cables round to a suitable position, in the outside soil, with the added advantage that longer bends can usually be given to the cables. The opening of the ducts into the chamber should be carefully finished to avoid abrasion of the cables on drawing in. Preferably white-enamelled bull-nose bricks should be used; but where this is vetoed on account of expense, the opening in the wall should be bell-mouthed with as wide a sweep as possible, and finished with neat cement carefully smoothed.

The efficient draining of the man-hole frame is of prime importance. Self-draining covers are made which are arranged to drain into an artificial ground made up of gravel, ballast, cinders or such porous material. Such devices are, however, apt to become choked up by the mud which continually works through the interstice between cover and frame. It is better practice to utilise the nearest street drain, provided that there is no danger of this becoming flooded, and that the connecting pipe, taken from the lowest side of the cover, has sufficient drop to carry away the water. Such a pipe is cheap to install, and can be periodically cleaned with a cane. Where some distance has to be traversed between the cover and the drain, a brick box may be put in halfway between the cover and the drain—say, 14 × 14 × 8 in.—the pipe from the cover coming in at the top of one side, and the pipe to the gutter or gully leaving at lower level on the opposite side. This box will then act as a mud trap.

The proper ventilation of an underground chamber is of great importance, as there is the ever-present danger, particularly where bituminous insulated cables are used in a draw-in system of pipes, of gas accumulating in the chamber; and also because, however well waterproofed the chamber may be, "sweating" on the walls and ceiling is almost certain to occur. This latter trouble may be minimised by painting or serving the roof; felt and wood have been used to cover the walls and roof for the same object, but as these materials are inflammable, they are objectionable in a chamber containing electrical gear.

Such an underground sub-station is usually fitted with a 5 or 6-in. pipe leading from the floor level of the chamber to a ventilator frame in the footway above. Where there is any danger of this becoming flooded, posts are erected near the kerb of the pavement, carrying this ventilating pipe some 3 ft. above ground level to an air-grid in the post. On the other side of the chamber there is a similar arrangement of pipe and ventilator grid, the aperture in the chamber being now, however, at the top of the wall, preferably close under the manhole cover (fig. 2). If possible, the level of the exhaust "port" or opening into the street should be at a higher level than that of the admission port, any natural slope of the road being taken advantage of. The object of this is to facilitate the circulation induced by the rising of warm air, and the inflow of the colder outside air to replace it. Where such natural circulation does not exist to a sufficiently large extent, a small exhaust fan driven by a high-speed motor should be fixed at the chamber ventilator duct. The power consumed by such a motor is inconsiderable compared with the capacity of the sub-station, and the loss will be much more than counterbalanced by the dryness and high insulation of the gear. Whether the fan be made a permanent institution or not, it should most certainly be used for the first four or six months after the sub-station has been built, as new walls of brick and concrete contain a tremendous amount of moisture which has to be gradually dried out. During the process of building the chamber, it is good practice to keep one or two "devils" containing coke continually burning in the pit; these should be maintained after the chamber is complete and before the electrical gear is installed, and during the "baking" of the transformers which is usually given in order to dry them out before they are set to work, full advantage should be taken of the heat developed, by leaving the transformer cover off, the hot air then drying the room.

In conclusion, the writer desires to point out that he has gone as little as possible into dimensional details of design, his object being rather to place before readers a few general considerations, in the main simply applications of common-sense, governing the successful construction of such chambers, which details are by their simplicity apt to be neglected.

MECHANICAL COAL CUTTING.

[*Report of the Committee upon Mechanical Coal Cutting.—North of England Institute of Mining and Mechanical Engineers. Published by the Institute.*]

This report, coming as it does from such a body as the North of England Institute of Mining and Mechanical Engineers, is stamped as authoritative, yet from an electrical point of view it seems to us a little disappointing. The Committee appointed consisted of gentlemen who are all strictly "mining" engineers, and, for the most part, are all engaged in the management of the large colliery concerns in the North of England. We do not suggest for a moment that such a body of gentlemen are not capable of adequately judging and reporting upon the advisability of installing electrical coal cutters, but we venture to question their competency to deal with electrical matters, such as one might expect from the report—that is, in regard to details of construction, types and arrangement of machines, and their advantages or disadvantages, comparison of three-phase and continuous-current machines, methods of installing and fixing cables, &c., all of which points are practically omitted, yet are just what are wanted at the present time. At any rate, we think the value and usefulness of the report would have been very much enhanced had an electrical engineer conversant with colliery practice, or, in other words, a colliery mechanical and electrical engineer, served upon the committee. Such a person, too, would perhaps have balanced the very evident bias or leaning towards "compressed air."

Colliery managers are notably conservative, and probably most so in the North of England, where old methods and customs handed down from generation to generation are difficult to break down, and hence although conditions are most favourable, especially for "heading" machines, as "in a district such as the North of England, where the bord-and-pillar system of working is largely practised, there is undoubtedly a field for the use of these machines," yet probably there is a less proportion of coal-cutting machines working in the coalfields of Durham and Northumberland than in any other.

The report is in two parts, Part I dealing with "longwall" machines, and Part II dealing with "heading" machines; for the purposes of the report, letters were sent to owners of collieries in the United Kingdom using coal-cutting machines, with a request for information as to:—(1) The names and number of machines in use; (2) the time during which they had been in use; (3) the motive power; (4) the thickness of seam; (5) the depth of cut; and (6) the tons of coal under-cut during the previous year. Replies on these points were obtained from some 80 colliery companies, covering about 200 machines, and show that:—

1. Disk machines in longwall-faces are most generally in use at the present time.

2. Few collieries have been using them for more than six years, or to any large extent.

3. Compressed-air machines are still in a large majority, although electricity is being increasingly used as the motive power.

4. The thickness of seams in which longwall machines are in operation, varies from 1 ft. 1 in. to 6 ft. 6 in.

5. The depth of cut runs from 2 ft. 10 in. to 7 ft.

6. The amount of coal cut per machine averages, roughly, 13,000 tons.

A selection of some 30 collieries was then made, where the conditions were widely different, and the machines inspected when at work in the coal face, and as full information as possible obtained by personal interview and subsequent correspondence, which is given in a schedule at the end of Part I. The report deals very fully with "hours and conditions of labour," "cost of working," &c., which is valuable information to the colliery manager, and "The three chief points to which attention has been directed as being the most important in deciding on the adoption of coal-cutting appliances are the following:—(1) The cost of working as compared with hand labour; (2) the increased production per man employed; and (3) the increased percentage of round coal." On the first point no very definite conclusion is arrived at, as the results vary very considerably, and no distinction is made between electric and compressed air machines. There is no doubt, however, on the second point as "the result of the adoption of coal cutters has been to increase the production of coal per man employed, the average increase in the production amounting to about 65 per cent." The importance of this fact is impressed upon the Committee, as they say:—"This, it need hardly be remarked, is a matter of the very greatest importance at the present day, when labour is becoming more difficult to obtain, and is more costly in many ways, requiring the provision of increased house accommodation, with its attendant increase in rates and other charges—more especially in Northumberland and Durham where the system of free houses and free house coal is so firmly established. This seems to point to the possibility of collieries, in which the thicker and profitable seams have become exhausted, being kept at work where otherwise such losses would probably be incurred as would lead to their being closed . . . . (as) in this way the output may be maintained on such a scale as may be necessary to keep the standing charges of a colliery working thin seams at a normal figure." On the third point the increased percentage of round coal is given as from 5 to 20 per cent., and, of course, where the selling price depends upon the size of coal, the increase is of the greatest importance, as it results in a higher average selling price. Further, in some cases where the seams contain bands, it is often possible to under-cut in the band itself, and so obtain cleaner coal.

"Conditions of Working" are next dealt with, then follow "Machines," under which heading (I) disk machines; (II) bar machines; and (III) chain machines are briefly described, but it is worth noting that not a single illustration of a "longwall" coal-cutter is given, whereas nearly every type of compressed-air "heading" machine is illustrated.

With regard to the speed of the machines, most of the cutting wheels revolve at a speed of from 15 to 30 r.p.m. for the smaller sizes and from 10 to 12 in the larger sizes. One English (compressed-air) and one American machine, however, form exceptions to this rule, the former revolving at 60 r.p.m., the ratio of gearing being 2 to 3 to 1, whilst the latter in the electric driven type revolves at 50, and 45 when driven by compressed air. Generally in electrically driven machines the ratio of gearing between the motor and disk is about 65 to 70 to 1; and in compressed-air machines, 20 to 25 to 1. No indication, however, is given as to what is the best speed for the cutting tool in different strata, which is really what is wanted, and some information on this point would be valuable to makers of coal-cutting machinery. We certainly think that a series of experiments, which could, no doubt, be easily arranged and carried out by the Committee, would be a very valuable contribution to this question. Again, "The machines are fitted with driving gear with variable speeds for hauling them along the coal face," but what these speeds are, or what is most suitable for the strata, is not mentioned. As to the value of variable speed gear, we believe this to be questionable, as in all probability most machines will be found—especially when the men are paid by results in actual cutting—working on the top notch. It is all very well for makers to say the speed of advance should be regulated to suit the power of the machine, the men say the machine is to undercut, and the more they can cut the more they get paid and "blow" the fuses.

In describing the "Diamond" machine, we are told that "in its electric form the two motors are run in series, so that the full *tension* (the italics are ours) of the current (usually 500 volts) is divided, and that on either motor is only 250 volts, thus reducing the risk of burning out the coils." Why do they use the word tension? And, further, why is there less risk of burning out the coils? The motors are only wound to withstand 250 volts, and as a matter of fact, it is a moot point as to whether a coal cutter is not better with only a single motor, as in a two-motor machine, one is liable to absorb more energy than the other, and ultimately break down. In describing the "Hurd" bar machine, the bar is described as being tapered, but we believe we are correct in saying these machines are now being fitted with "parallel" bars, although these are not mentioned in the report. Another important point with electric coal-cutters is the type of "starting switch" used, but this again is left severely alone.

"Cutting Tools" and "Rails" are next dealt with. With regard to the latter, we think the last paragraph, viz.: "As a rule, it appears to have been found better to use rails, despite the labour of constantly taking them up, passing them forward and relaying them," ought to be deleted, or, at any rate, modified, as at the present time probably the greatest proportion of coal-cutters will be found to be upon "skids." These may absorb a little more power; but "it's worth it." On "Motive Power" we read, " . . . . the greater efficiency of electricity, and the simplicity and lower cost with which it can be conveyed from the surface to the face, has led to its increased introduction for power purposes. For coal-cutting its use is extending very rapidly at the present time." But we think the section under "Electric Cutters" should be revised by someone familiar with electrical matters, as it is no good recounting the early difficulties with electric coal-cutters, when the machines were admittedly manufactured with motors considerably under the power required. In a well-designed plant, for which a fair price is paid, there is absolutely no trouble with electric coal-cutters, and we certainly see no justification for the following:—"More skill and attention is undoubtedly required than is the case with compressed air." We are, however, glad to read, "It is of the greatest importance that electric plant should be of a high class, both as regards material and workmanship, and that there should be no cheeseparing about an installation. A properly constructed plant will give satisfaction, but an inefficient one probably gives more trouble than anything that can be put into a colliery, and *it is the worst form of false economy.*" The italics are ours, and we hope colliery managers for their own sakes will read and act upon this advice. It is no use attempting to settle an installation upon "price," or by setting off one contractor against another, in order to secure reductions, as electrical engineers can no more live without profits than can colliery owners, and with the former competition is too keen for them to "wax fat," as a rule they are very "lean."

On "Capital Expenditure," the Committee say:—"From careful estimates of a first-class plant of either sort, consisting of generating plant complete, and the necessary cutters and their accessories (including two spare machines, without pipes or cables) suitable for a pit at which it is desired to run 10 machines, the cost per machine works out at about £1,000 in the case of compressed air and £1,100 in that of electrically-driven machines. Electric machines are more expensive than compressed air machines, the large ones costing about £350 to £450 each, as against about £250 for compressed air machines." On the other hand, "the estimated cost of pipes or cables for a plant of the dimensions named above, including all face connections, works out at about £270 per machine for pipes and about £200 for cables, assuming that the depth of the shaft is 600 ft., and that the distance from it to the workings is 4,200 ft." Whilst no doubt the foregoing is interesting, as it dissipates the notion that electric plant can be put down for little or nothing, and costs nothing when it is down, it forms no reliable guide as to what an individual coal-cutting plant would cost. We note that no point is made of the *greater efficiency* of electrical plant compared with that of compressed air, when considering this question of cost.

The remainder of Part I of the report deals with "Labour with the machine" and "costs," which, no doubt, will be extremely valuable to mining engineers and others interested, as they are thoroughly dealt with in detail.

As previously mentioned, Part II deals with "Heading" machines, which are principally compressed-air driven. It is important to notice that "In America . . . . in 1899 the percussive or puncher type was 63·9 per cent. of the total, and in 1903 only 52·4 per cent. Probably this is chiefly due to the growing employment of electricity as a motive power, and to the fact that no reliable electrical percussive machine exists at present." There are, however, *some* electrical percussive machines, and we think it only fair that they should have been included. On "Motive Power" the mechanical engineer appears to have been abroad, as "the Jeffery header, when air-driven, does not require so high a pressure as the percussive machine, and will work with a pressure of 40 lb. per sq. in. when cutting a fairly hard band, although a pressure of 50 lb. gives better results." Surely it is immaterial what pressure is used so long as the air cylinders are designed to suit, and if a pressure of 60 lb. or higher can be supplied, why not arrange the cylinders accordingly and obtain the benefit of the higher pressure.

On the whole, the report is of real value, and if we may offer a suggestion, it would be to place upon the Committee one or two members of the Institution who are practising as colliery mechanical and electrical engineers, and to revise and re-issue the report, embracing all the latest data upon the question, say, in another year's time, when we have no hesitation in saying that it would be of national importance.

POWER-OPERATED HATCHES.

ARMOUR hatches have been a problem ever since the protective deck was introduced. Means must be provided for raising and lowering the hatch plate quickly and safely under all circumstances, and as the plate weighs sometimes as much as half a ton, the problem is by no means a simple one.

Block and tackle, which has been used in the past, is inconvenient and dangerous, because the plate is likely to become unmanageable when the ship is rolling. Accidents from this cause have been frequent. The one thing essential to the safe handling of these heavy plates is that they be mechanically held at all times so that they cannot drop or swing back. This result has been accomplished in the "long-arm" electrically operated hatch gear, of which a new model has just been approved by the Bureau of Construction and Repair of the United States Navy Department.

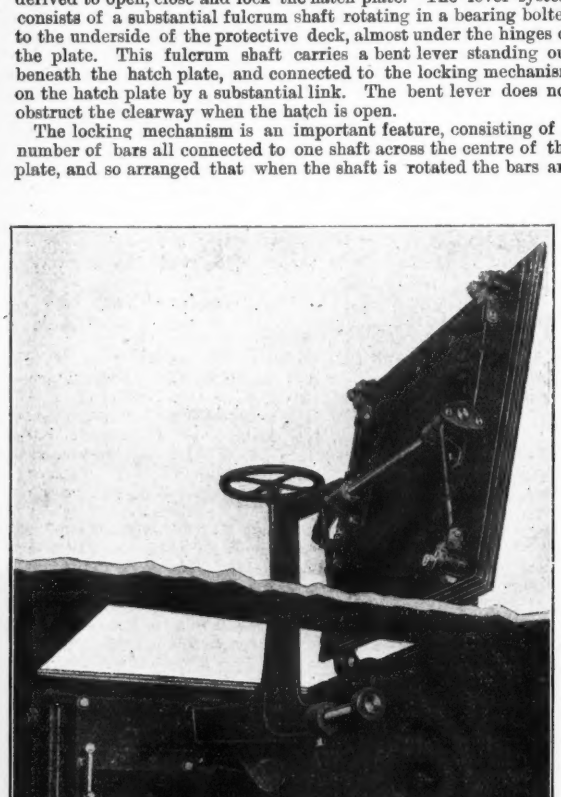
F

This gear is so designed that the hatch plate while being operated, is always under control and held firmly, at whatever angle the plate may be to the deck.

The two essential parts of this apparatus are the hatch lift—a cast-steel box containing the motor, controller and gearing; and the lever system for connecting the hatch lift with the plate for operation, and for locking the plate water-tight when closed.

The hatch lift is secured under the deck by the side of the opening. Projecting from the side of the hatch lift is a heavy crank which can be rotated either by the motor or by an auxiliary hand wheel, above or below deck. From this crank power is derived to open, close and lock the hatch plate. The lever system consists of a substantial fulcrum shaft rotating in a bearing bolted to the underside of the protective deck, almost under the hinges of the plate. This fulcrum shaft carries a bent lever standing out beneath the hatch plate, and connected to the locking mechanism on the hatch plate by a substantial link. The bent lever does not obstruct the clearway when the hatch is open.

The locking mechanism is an important feature, consisting of a number of bars all connected to one shaft across the centre of the plate, and so arranged that when the shaft is rotated the bars are



Long-Arm Electrically Operated Armour Hatch.

forced out beneath the deck and draw the hatch plate firmly down to its seat. The mechanism is actuated by the lift, and does not require separate manipulation. When the hatch is closed and locked, and the operator starts to open it either by hand or power, the lift first unlocks the plate, after which it opens to any desired extent. A mechanically operated stop prevents the locking gear from throwing out the bars except when the hatch plate is completely closed.

The motor and controller of the hatch lift are connected with a central emergency station located above deck, and form a part of the system by which the main bulkhead doors of United States warships are controlled from the central station. The hatch lift, in common with the "long-arm" system doors, possesses a "liberty action" which enables a man who may desire to pass through the hatch while it is being closed from the central station or after it is completely closed, to arrest and reverse the power action. This is accomplished easily and sately, simply by turning the controller handle (shown in the illustration at the left of the power box). When this lever is manipulated, the closing operation is suspended and the hatch opens sufficiently to allow passage through the opening. As soon as the controller handle is released the hatch automatically closes again, as though no interruption of the emergency closing had taken place.

The great importance of this feature of the mechanism is that it eliminates danger and gives freedom to those who may be compelled to pass through the hatchway while it is being closed from the emergency station.

In common also with the "long-arm" doors, the hatch lift is provided with an automatic cut-out, so that in case an obstruction prevents the complete closure of the hatch plate the current to the motor is cut off, preventing injury. After the obstruction is removed the motor is automatically started, this follow-down action doing away with the possibility either that the apparatus will be injured or that, after an emergency closure is interrupted, the hatch will be left open by some one passing through it.

The "long-arm" hatch gear thus offers three methods of operation—at the hatch, both above and below deck, by power which is brought into action by means of the controller handle; above and below deck by means of the hand gear intended for use in case the electric power should fail, and from the emergency station on the bridge, by means of which the closing of all power-operated hatches on the ship is always instantly possible.

CORRESPONDENCE.

Letters received by us after **5 p.m. on Tuesday** *cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.*

Corrosion of a Brass Gas-Pipe.

In searching for an escape of gas under the floor, we found it in a $\frac{3}{8}$-in. brass tube, where it crossed a Simplex conduit tube carrying the cable for a few electric lights. The top of the brass tube was covered with verdigris for about 6 in., and a small slit was in the tube from which the gas escaped. The distance between the two tubes was about 1 in., and they have been in the same positions under the floor for about six or seven years.

We were wondering if it was possible that a chemical action had been set up by the nearness of the electrical tube, or whether it was simply a coincidence that this slit and verdigris should be just over the electric wire. If the former is the case, there is evidently a possible danger which must be taken into account, and which is well worth the notice of both electrician and gasfitter.

We should be glad to hear if any others have had any similar experience.

E. G.

August 23rd, 1906.

Circulating Library of Technical Works.

It has often occurred to me that it would be a great boon to engineers and students in electrical engineering if there were a circulating library from which they could obtain books of reference on technical subjects. These books are often very expensive, and students in the provinces have often to content themselves with the ordinary text-books.

It seems as if the ideal arrangement would be a miniature Mudies' for engineering and electrical literature to be started, provided it could be made a financial success.

I feel sure that many of the supply companies and corporations as well as the larger firms of manufacturers and contractors would be glad to act as local agents. They would receive a box of books, say, once a month, and their annual subscription would be proportional to the number of books they would require at a time. Those of their employés who wished to avail themselves of the volumes would pay a share of this subscription.

Each month a list would be sent up of books required, and as far as possible these would be sent down the next month, or if in use, a month or two later.

Suppose the annual subscription were 5s. per volume, or what amounts to the same thing, 5s. per head, would this, in your opinion, be enough to make it pay? If so, would you, Sirs, feel prepared to undertake the scheme? You are in the position to buy electrical literature as cheap as anybody, and it would also be a means of circulating your own publications.

I should be very glad to see your views and those of some of your readers.

Resident Engineer.

August 25th, 1906.

[A similar idea was put forward, we believe, about a year ago, in Manchester, and some attempt was made to carry it into practice. The fact that nothing has been heard of the project of late suggests that it was found impracticable, or that adequate support was not forthcoming. No doubt there are many who would profit by such an arrangement. On the other hand, the high price of technical works is at least in part due to their limited circulation, and it can hardly be expected that technical publishers will view with favour a proposal of which the tendency would certainly be still further to reduce their sales. We doubt whether 5s.

per head per annum would be nearly sufficient to cover the cost—10s. 6d. is a moderate annual subscription for non-technical libraries, where the volumes cost only a few shillings each, and where the *clientèle* is far greater. As regards ourselves, we do not see our way to take the matter up.—EDS. E.R.]

The Single-Phase Induction Motor.

Mr. Pensabene Perez has, I think, slightly mistaken the drift of my letter dated June 16th, and I have, perhaps, not made myself quite clear. I am also well aware that the theory I have put forward is at first rather elusive, and one is apt to think the rotor is asked to do more than its fair share of work, but when once that initial difficulty is overcome, it is marvellous how simple the whole thing really becomes, and what a clear insight one gets into the operation of single-phase motors in general.

We had agreed that for an ideal motor, provided with a rotor carrying a continuous-current winding connected to a commutator and short-circuited by means of brushes disposed along two axes displaced by 90 electrical degrees, the no-load current must equal the magnetising current; but we were not agreed that such a motor was in every way identical with a squirrel-cage motor.

In mine of June 16th I set out to show not only that these two motors really were identical, but that the no-load current for the ideal squirrel-cage motor was also equal to its magnetising current. For this purpose I selected as a simple example a rotor provided with a two-phase winding, each of which was short-circuited on itself. I assumed synchronous rotation, and I also assumed the existence of two fields M and M_1 displaced in space and phase by 90°, but I went on to show that for every position of the rotor the motor field M_1 was due to a current i_2, which in turn was due to the E.M.F. (E R) generated by rotation in the transformer field M.

This is fairly apparent all through my letter, and I think is made quite evident in the *résumé* column 1, lines 1 to 11, on page 996. In some of my publications I have shown in a direct manner how the motor field M_1 was generated; in this particular case, and without previous warning, I chose to show the same thing indirectly, and have thus, no doubt, misled Mr. Pensabene Perez. I demonstrated that the existence of certain currents in the rotor tallied exactly with the existence of M_1, that these currents were responsible for M_1, and that they were due to an E.M.F. generated by rotation in the transformer field M.

Mr. Pensabene Perez evidently still thinks that there ought to be no currents at no-load in the rotor of a single-phase shunt-induction motor. I am sure that he knows as well as I do that such currents *do* exist, and that they are absolutely necessary for the operation of the motor. If that is so, is it not self-evident that any theory, be it the rotating field theory or any other, which proves that no such currents exist, must be wrong?

If, as Mr. Pensabene-Perez suggests, I were to deal in a similar way with a two-phase motor, I should certainly not arrive at the same conclusions, for in that case both fields are excited from the stator, and the magnetising current for M, as well as for M_1, is carried by the stator windings. To put the matter in a nutshell, a two-phase shunt induction motor is separately excited, whereas a single-phase shunt induction motor is self-excited.

Now as to the omission which, according to Mr. Pensabene Perez, would modify my results. The question is, what is the action of M_1 on D at the instant under consideration, or, generally, what is the action at any time of M_1 on the circuit carrying i_2?

The answer is simple, and is really implied by saying that i_2 lags 90° behind E R. In the axis of M_1 we have a transformer on open circuit, E R is the E.M.F. applied to the primary of that transformer; i_2 is the resulting magnetising current, M_1 is the resulting flux. M_1 reacts on the primary of the transformer in the usual way, and sets up a back E.M.F. opposite in phase to E R. This very reaction is, of course, the reason why E R does not set up in the winding on which it acts, a current simply proportional to E R and to the ohmic resistance of that winding. There can be no question of this back E.M.F. (or E.M.F. of self-induction), producing a current equal and opposed to i_2, no more than in the case of an ordinary transformer, and my conclusions, therefore, remain unaffected.

Touching the less important question of the power-factor of a motor with commutator and brushes short-circuited at 90 electrical degrees, I am quite prepared to add to my somewhat scanty remarks on this subject. Such a motor, when standing still, must I think undoubtedly be considered as a short-circuited transformer with a good deal of leakage. The power-factor of a short-circuited transformer can, however, not be greater than the power-factor of that same transformer when normally loaded. The power-factor will generally be the higher the higher the losses, and, therefore, the power-factor of a motor when standing still will as a rule be higher than the power-factor of a corresponding transformer, but will not I think under any circumstances be higher than when that motor is running at about full-load.

I hope soon to have an opportunity of making some tests relating to the no-load current question, and will, if possible, also investigate the value of the power-factor at standstill. It will be much more difficult to investigate the no-load current in the case of a squirrel-cage rotor than in the case of a commutator-motor, but perhaps Mr. Pensabene Perez is now prepared to accept my view that a squirrel-cage rotor is identical, as far as the mode of operation is concerned, with one provided with a commutator and suitably short-circuited by means of brushes.

Val. A. Fynn.

London, *August 25th*, 1906.

Rail Corrugations.

I have read with much interest the articles on the above matter appearing in your issues of the 27th ult. and 3rd inst. I trust that these articles will arouse the interest which the importance of the subject deserves from tramway engineers.

In Ipswich, I find corrugations on straight track as well as on curves of very large radius, but so far I have not come across any corrugation on sharp curves. In my efforts to find a reasonable explanation for the phenomena, I have gone to the trouble of measuring the wave lengths of corrugations where they have appeared on the different parts of the system, and it is of interest to note that the wave length is about the same in all places, viz., $2\frac{3}{8}$ in. from crest to crest. I further find that the crest of the corrugation is generally very hard, whereas the hollow part is soft. This, at first thought, would appear to support Mr. Annan's theory that the flow of electricity along the rail is responsible for this change of ductility. I cannot, however, agree with this view, since some of our corrugations have appeared on a length of line running out into the country where the traffic is very light indeed, and under these conditions not more than 100 amperes as a maximum can be flowing at any time through a pair of 90-lb. rails. Possibly the hardness is due to a molecular change in the metal, due to the pounding of the wheel at high speed, which is a necessary accompaniment of corrugations.

You state that corrugations have been reported on American light electric railways presumably employing sleeper construction, and a comparison of this statement with the fact that on British lines employing sleeper construction and ballast bed corrugations are unknown, leads one to infer that it is simply due to the well-known fact that only a few of the big steam lines in America (and possibly some of the more lately constructed heavy electric railways) have the track properly ballasted as we in this country understand it. I believe it is a rule in the States, in the case of light electric railways, to put down the track, in the first instance, with practically no ballasting at all, and it is conceivable that with certain qualities of subsoil one could, in dry weather, get a bed almost as hard and unyielding as concrete.

According to Mr. Paton's theory, one would rather conclude that, on a line employing motors whose armatures were mounted direct on the main axle, corrugations would be unknown. I would, however, like to point out that on the City and South London Railway, where the armatures are mounted direct on the main axle, corrugations are to be found.

They can be clearly seen in Moorgate Street Station, and possibly at other places.

I have been interested to learn lately that a so far successful attempt has been made to get over the corrugation trouble at Glasgow by putting felt or similar substance underneath the flange of the rail instead of concrete packing. If this is a cure, it would certainly seem to support the opinion which I and many other engineers have for some time held, viz., that the trouble is entirely due to a combination of vibration and a solid unyielding bed. But I fear very much that the use of felt, while it may in itself cure the corrugation trouble, will lead to trouble with the paving joints, because directly the rail commences to move, the joint between the setts and the rail breaks and lets water get down. I suggest that it might be worth while considering what effect would be obtained by using a type of wheel which would cushion the dead weight of the motors. I believe that if we could arrange to carry the whole weight of the motors on springs and to have some yield between the teeth of the gear wheel and the main axle, we should find corrugation troubles much less frequent. Possibly the use of combined steel and wood wheels—as used on many railway coaches—might have the desired effect. Or it might be possible to employ rubber or steel spring cushions inside the wheel structure.

Frank Ayton,
Chief Engineer and Manager.

Ipswich, *August 21st*, 1906.

Manufacturers Selling Direct to Consumers.

"Transgressor" makes a mistake when he says that we admit that we do no business with the Electrical Co., who supplied direct the lamps and burners complained of. All we said was that their representative did not call on us (or others in the trade), and for the very good reason, we would suggest, that he might be recognised by one of the trade when calling on a draper.

As a matter of fact, we have been doing all our Nernst business with this particular firm, but they may rest assured that we shall endeavour to cut it as low as possible in the future.

The Northern Electrical Co.
pp. J. P. C.

Doncaster, *August*, 1906.

The Penetrating Properties of the Arc Light.

In his letter in your issue of August 17th Mr. Marinier maintains that yellow and red light penetrate a mist-laden atmosphere better than green and blue light, and he refers to the colour effect of the sunset in support of his views; but a little consideration will show him that the red colour at sunset is almost entirely due to the effect of refraction, and the truth of this can be best appreciated when it is remembered that parts of the same cloud at sunset are often red and white respectively.

Some time after the sun has sunk below the horizon, when it is nearly dark, it will be found that the sky cannot be seen at all through a red glass, whereas a blue glass is still quite transparent.

According to my understanding, distant objects appear blue because although the distant objects may have a white surface and must, therefore, reflect towards the observer all the colours in the solar spectrum, nevertheless, all these colours are absorbed by the atmosphere except the blue, which alone persists, and produces the blue impression upon the observer's eye.

Mr. Marinier entirely misses the principal point raised in my previous letter, viz., that one illuminant will radiate more penetrating rays than another, if the luminous surface area is proportionately larger in one case than the other, and the light at the surface area is consequently at a lower light density; and I maintain that it is for this reason that the light from a 100-watt mercury arc will penetrate a fog better than the light from a 500-watt open carbon arc, which I proved to be the case some time ago, and which can again be proved under suitable atmospheric conditions.

I have stated before, and I repeat here, that I do not consider that this question of light-density is taken properly into account in connection with light penetration, though it must influence photometric measurements much more than the Purkinje effect.

C. Orme Bastian.

London, N.W., *August 27th*, 1906.

An Attempt at Corruption.

In your issue of August 24th Mr. Ackermann gives a deplorable instance of attempted corruption and bribery by some firm dealing in instruments.

Your readers will hardly require any denial from us in order to be assured that the firm in question is not among those who sign this letter, but perhaps you will allow us to state, individually and collectively, that we do not offer bribes, either openly or veiled as fees or commissions, to those who represent the buyer and stand in a fiduciary position towards him.

In the short time at our disposal we have not been able to communicate with every instrument maker, but we are convinced that the statement we have made is true of every firm of repute.

Elliott Bros.
Eversheds & Vignoles, Ltd.
Nalder Bros. & Thompson, Ltd.
Everett, Edgcumbe & Co., Ltd.
Kelvin & James White, Ltd.

London, *August 28th*, 1906.

[We have much pleasure in stating that the firm mentioned by Mr. Ackermann was not an electrical firm.—EDS. E.R.]

"ACME" INSULATING TAPE.—A correspondent wishes to know the name of the makers of this tape.

The name of the makers of the "VOLTA PAVIA" batteries is inquired for.

BUSINESS NOTES.

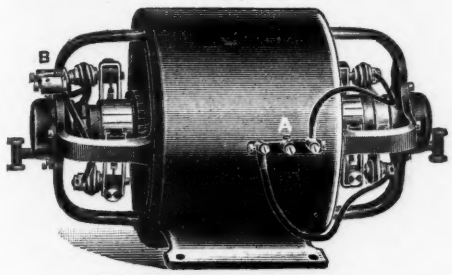
Bankruptcy Proceedings. — BERNARD SHERMAN, electrical engineer, 16 and 17, Devonshire Square, E.C.—This public examination was held on Tuesday before Mr. Registrar Linklater. The statement of affairs shows total liabilities £1,526 5s. (unsecured £1,363 3s.) and net assets £252 17s., after deducting £38 2s. from the preferential claims. Questioned by Mr. Walter Boyle, Assistant Receiver, the debtor stated that in 1902, with a capital of £270, he commenced to trade alone as an electrical engineer and telephone specialist, under the style of Sherman, Redfern & Trench. In January, 1903, he was joined in partnership by Mr. D. H. Muston, who introduced £150 capital and paid £250 for a half-share of the goodwill, and in April, 1903, they were joined by Mr. F. H. Rogers, who paid in £150 and acquired a third share of the business. The firm bought in April, 1903, certain patents for dry cells for £1,500, and in the following August they sold the patents to the Amalgamated Dry Batteries, Ltd., for £600 payable in cash and £15,000 in shares. The latter had been partly sold or transferred to, or deposited as security with, other persons. The partnership with Muston and Rogers was dissolved in 1905, on account of mutual differences, witness taking over the liabilities and assets, and continuing the business alone. He had since endeavoured to exploit various patents, and lost considerable sums of money thereby. In February, 1906, he sold his telephone business and connection for £60. The examination was concluded.

Camp Conduits for Telephones.—The Administration of Belgian Posts and Telegraphs has decided to place the telephone cables underground in the town of Charleroi and suburbs, and the entire order for conduits has been given to Mr. DOUGLAS WELLS, of Brussels, Continental agent for the H. B. Camp Co.'s conduit. This is the fourth town in Belgium where these ducts have been adopted; installations at Brussels and Liége are completed, over one million feet have been laid in Antwerp, and the Administration hopes to complete by the end of this year nearly another million feet for this town and suburbs; the agents for the H. B. Camp Co. in London are Messrs. James F. Cummings & Co., 27, Chancery Lane. The Belgian Government hopes to commence putting the cables underground in the town of Ostend next year. For Antwerp the cables were supplied by Messrs. Felten & Guilleaume, no English firm tendering.

Hudson-Bowring Life-Guards.—A contract for the fitting of these lifeguards to the Birmingham Corporation's 150 new cars has been placed with MESSRS. HUDSON & BOWRING, LTD., of 33, Brazennose Street, Manchester, who have also received orders for 15 sets of life-guards for Rangoon, 40 for the North Metropolitan Tramways, 14 for the Lancashire United Tramways, and a number of smaller orders.

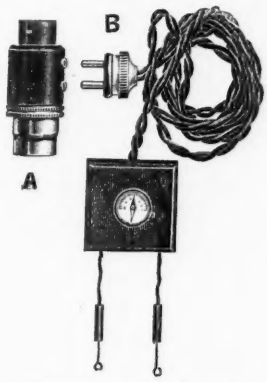
Alleged Theft of Telegraph Wires.—On Saturday last, a man named William Webb was charged at the North London Police Court with stealing and receiving copper wire from the telegraph lines of the Great Eastern Railway. The wire was found in the house of the prisoner, who was remanded on bail.

Motor-Car Battery Charging Apparatus.—Messrs. Ward & Goldstone, of Strangeways, Manchester, have introduced a neat little D.C. transformer styled the "Multum generator," which can be connected to a lampholder on an ordinary



"Multum" D.C. Transformer.

lighting circuit, and gives out current at a voltage suitable for charging accumulators for motor-car ignition purposes, &c. This machine, which is illustrated herewith, is supplemented by a special switchboard fitted with ammeter, voltmeter, regulating resistance, &c. Where it is preferred to charge direct from the mains, in spite of the waste incurred by doing so, the "Indispenso" adapter can be used; this is also illustrated, and consists



"Indispenso" Adapter.

of the adapter A, which can be inserted into an ordinary bayonet lampholder, and the plug connection B, which carries at one end a plug to fit the socket on the adapter, and at the other end charging terminals, in series with a polarity indicator. The current obtained depends upon the resistance of the lamp which is put in the holder of the adapter A, and can thus be regulated to suit requirements. These and other motor-car accessories are described in a small booklet and price list recently issued by the company.

Theft of Signalling Apparatus.—A telephone lineman named Joseph Fearnley, of Earlsheaton, was charged on Monday with stealing apparatus from signalling cabins belonging to the Lancashire and Yorkshire and London and North-Western Railway Companies. It appeared that prisoner had broken into cabins at Dewsbury, Mirfield, Heckmondwike and other places, and removed telephone and telegraph instruments, thereby endangering the safety of trains. Part of it he used to fit private houses with telephones. The prisoner was sentenced to six months' imprisonment.

Zirconium Incandescent Lamps.—The Lahcarriere Co., of France, has acquired the patent for making Zirconium incandescent lamps, and is now erecting works to construct the lamps on a large scale.

Gas and Oil Engines in Italy.—The firm of Langen and Wolf, one of the largest manufacturers of gas engines in Italy, have recently published their balance-sheet, made up to June 30th last, showing that the business has been of a most satisfactory nature, enabling a dividend of 12 per cent. to be paid.

L'Elettricita, of Milan, for July 27th last, publishes an interesting note on the economical working of Diesel oil engines in many parts of the Continent, but mentions that there are very few examples of this engine at work in Italy, owing principally to the high price of liquid fuel, due to the heavy import duties to which such fuel is subject.

Tantalum Sun Lamps.—We are informed by Messrs. Siemens Bros.' Dynamo Works Ltd., of York Mansion, York Street, Westminster, that the price of the Tantalum Sun lamp, with gallery and holophane shade, will be reduced, as from September 1st, from 8s. 6d. to 7s. 6d., and the bulb only from 4s. 6d. to 3s. 6d.

Catalogues and Lists.—Messrs. Johnson & Phillips, Ltd., Charlton, S.O., Kent.—Price-list H of electric arc lamps, dealing with open and enclosed types, and with the "Juno" flame arc lamp.

Messrs. Schoen Bros., 29, Cock Lane, Snow Hill, E.C.—Leaflet relating to Mr. G. Kestermann's raw-hide wheels and cut gear, for which the firm has acquired the sole agency.

Messrs. Stocker & Co., of Leipzig, notify us that their new wholesale catalogue is ready for issue, and will be sent to the trade on application.

Messrs. Philips & Co., Eindhoven (Holland).—Booklet dealing with incandescent electric lamps of all sizes and voltages, and of various shapes and types, many of which are illustrated.

Messrs. Thorn & Hoddle Acetylene Co., Ltd., 151, Victoria Street, S.W.—Pamphlet relating to the "Incanto" oxy-acetylene system of autogenous welding. The "Incanto" acetylene generator and purifier, the blow pipe, and the oxygen pressure regulator are illustrated and described, and directions are given for the use of the apparatus. It is stated that the cost compares favourably with that of riveting or brazing, and demonstrations of the process are given on request.

Mr. G. Braulik, 217 and 218, Upper Thames Street, London, E.C.—Price list of motor fans, large and small, for D.C. and A.C., and for various modes of mounting; also standard semi-enclosed motors from 1 to 18 H.P.

Messrs. Fielding & Platt, Ltd., Gloucester.—Card showing a "Fielding" suction gas engine of 85 B.H.P. driving a dynamo through Fielding's patent flexible coupling.

Messrs. The Union Electric Co., Ltd., Park Street, Southwark, S.E.—Illustrated pamphlet showing recent examples of high-pressure switchgear supplied by the company to various installations, mainly for mining purposes, but suitable also for other installations, and including enclosed and cellular designs, as well as an automatic starter for a 700-H.P. motor.

Also a price list (No. 8,005) of "Union" hot wire ampere and voltmeters for D.C. and A.C., fixed and portable, and a price list (No. 1,371) of D.C. search light projectors with automatic feed.

Trade Announcements.—Mr. Charles L. Sturtevant has associated with him in the practice of patent law Mr. Eugene G. Mason, of Washington, D.C., who has had an experience of 12 years in the U.S. Patent Office as examiner, and more recently as acting law clerk to the Commissioner of Patents. The firm's name will be Sturtevant & Mason, with offices Rooms 601 to 604, Washington Loan and Trust Building, Washington, D.C.

Messrs. Johnson & Phillips, Ltd., Charlton, have substituted for their departmental telegraphic addresses a single one—"Juno, Charlton, Kent"—to which all telegrams should be addressed.

Messrs. James Gordon & Co., of 52, Lime Street, E.C., are removing on September 3rd to 81 and 83, Knightrider Street, Queen Victoria Street, E.C.

Messrs. Hadfield's Steel Foundry, Ltd., Hecla Works, Sheffield, have appointed Mr. Douglas Wells, of Brussels, sole agent in Belgium for the sale of their well-known "Era" Hadfield's patent steel for railway crossings, tramways, &c.

Messrs. Siemens Bros.' Dynamo Works, Ltd., inform us that they will open a branch office at 196, Deansgate, Manchester, on September 1st, which will attend to their interests in the counties of Lancashire and Cheshire, and also in North Wales.

Outing.—The employés of Messrs. Brown & Co., electrical cabinet makers, Glasgow, held their annual picnic on the 25th inst., the Glasgow Trades Holiday. About 150 of the staff and friends drove to Eaglesham, where they were joined later by a number of customers and friends; nearly 200 sat down to dinner, and in the course of the day sports were indulged in. Before the presentation of the prizes by Mrs. Jeffrey, Mr. Jeffrey, the managing partner, referred to the fact that the turnout was the largest they had ever had, and added that he had every reason to hope that the general improvement in business would ensure that the next outing would be even more largely attended.

Electrical Calculating Rule.—Messrs. A. W. Faber announce that they have designed a new practical calculating rule for electrical engineers, for the purpose of the rapid determination of the useful effect obtainable from dynamos and motors, the output in kilowatts and horse-power, and, given particulars of the windings, the loss in pressure either for continuous or alternating current. On the back of the rule formulæ are inscribed, to facilitate calculating the size of copper conductors for simple and polyphase systems.

India.—An industrial and agricultural exhibition will be held in Calcutta next December, during the Congress Season.

Book Notices. — "Air Compressors and Blowing Engines." By Chas. H. Innes. London and Manchester: The Technical Publishing Co. 4s. 6d. net.

"Marine Engineers, and How to Become One." By E. G. Constantine. Second edition. London and Manchester: The Technical Publishing Co., Ltd. 5s. net.

"The Engineering Press Monthly Index Review." Vol. VIII, No. 5, August, 1906. Brussels: Association de la Presse Technique. Fr. 2.50.

"Telegraph Secondary Cell Installations." By A. Crotch. London: Guilbert Pitman. 2s. 6d. net.

"L'Ozone." By E. Guarini. Paris: H. Dunod and E. Pinab. 2 fr.

"The Journal of the Franklin Institute." Vol. CLXII, No. 2, August, 1906. Philadelphia, Pa.: The Institute. 50 cents.

"Science Abstracts," Parts A and B. Vol IX. Part 8, August 25th, 1906. London: E. & F. N. Spon, Ltd. 1s. 6d. net each part.

"L'Electricité à l'Exposition Universelle et Internationale de Liége (1905)." By J.-A. Montpellier. Paris: H. Dunod & E. Pinat. 18 fr.

The Irish International Exhibition.—An event, which will, we hope, give an impetus to the development of Irish trade, will take place in Dublin in 1907—the opening of the Irish International Exhibition in May. It is the first exhibition of its kind to be held in Ireland, for nearly 40 years. It is hoped that manufacturers and others will give it their fullest support, and that every advantage will be taken of the opportunities afforded by the exhibition to display their products. Many offers of substantial support have already been received from Great Britain, the Colonies, India, America and the Continent. The exhibition grounds are excellently situated, and admirably adapted to the purpose. They will cover about 52 acres, including Herbert Park, recently made over to the public by the Earl of Pembroke. The organisation is under the presidency of the Marquess of Ormonde.

Brush Contracts.—Orders have been received by the Brush Electrical Engineering Co., Ltd., from Mr. J. Holden, Rheims, for a 300-KW. Brush Falcon engine and alternator, with two 180-H.P. three-phase motors, switchboard, electric pump, &c.; and Messrs. W. Cory & Sons, Erith, for a 220-KW. motor-generator, two transformers, 15 crane motors and controllers, and switchboard.

Liquidations, Dissolutions, &c.—Notice is given in the *London Gazette* for the 28th inst. of the issue of a winding-up order dated August 22nd in connection with the EMPIRE ELECTRIC LIGHT AND POWER CO., LTD., of Effingham House, Arundel Street, W.C.

BODIE ELECTRIC SYNDICATE, LTD.—A general meeting of this company is to be held at 312, Regent Street, London, W., on October 1st, for the purpose of receiving the report of the liquidator and statement of accounts.

Notice is given in the *London Gazette* of the intended payment of a dividend in the case of A. J. EARP, electrical engineer, Boscombe. Last day for receiving proofs, September 12th, 1906; trustee, Mr. W. F. J. Hunt, Midland Bank Chambers, High Street, Southampton.

LIGHTING and POWER NOTES.

Australia.—SYDNEY.—The Mayor in July last gave a brief account of the position of the Council's undertaking since it was inaugurated in July, 1904. The following we extract from the *Australian Mining Standard*:—"The first 18 months' working resulted in a deficit of £8,366. At May 31st last the capital account stood at £275,000, made up as follows:—£75,000, buildings; £100,000, machinery; £80,000, cables; £20,000, land, &c. The estimated net return for this year is put at £8,000, after allowing 4 per cent. interest, and 1 per cent. for sinking fund. From this sum, £7,000 is recommended by the city electrical engineer to be put aside for depreciation. Further extensions which the engineer contemplates for 1906-7 will cost £225,000."

Billinge (Lancs.).—The U.D.C. has decided to apply to the B. of T. for a prov. order for electric lighting.

Blackpool.—On the advice of Mr. Chas. Furness, borough electrical engineer, the Electricity Committee has recommended the T.C. to extend the plant at the works at an estimated cost of £7,000.

Mr. Furness has also recommended that the charges for energy for power to private consumers should be, instead of 2½d. per unit, 3d. per unit from 6 p.m. to 10 p.m. in summer and from 4 p.m. to 10 p.m. in winter, and 1d. per unit at all other times.

Bolton.—Messrs. Greenhalgh & Shaw, doublers, are extending their mills, and putting down plant for generating electricity.

Canada.—OAKWELL, ONT.—The inhabitants have voted a sum of $50,000 for the installation of an E.L. system.

PORT ARTHUR, ONT.—The Hydro-Electric Power Commission of Ontario has received an application from Port Arthur asking that the town be supplied with 1,000 H.P. immediately, and that provision be made for future increases. The matter is under consideration.

NIAGARA FALLS, ONT.—The tunnel of the Electrical Development Co. under the Niagara River and ending behind the sheet of the Horseshoe Falls is rapidly approaching completion, and it is anticipated that it will be ready for the water by October 1st next. To this end work is being hastened in the setting of two dynamos, with their connections to the transformer station, and on the transmission lines.

Chester.—An electrical exhibition is to be held in the town next month by the Corporation. It is to be opened by the Mayor on the 5th prox.

Continental Notes.—ITALY.—The authorities of the Province of Masso Carrara have granted a concession for a water-power plant to be put down on the River Magra at Podenzanza for generating electricity for lighting and power purposes.

The Prefect has granted a concession to Signor G. Ferre, of Belluno, to take sufficient water from the Ardo torrent to develop 300 H.P. for the installation of electrical works to supply the neighbourhood.

Sicily is not provided with water power to the same extent as the region of Italy near the Alps, but an engineer, M. Capito, has reported that from the rivers Alcantara and Sosio it will be possible to derive nearly 20,000 H.P., whilst three other rivers are named from which additional power could be obtained.

SPAIN.—The municipality of Puebla Larga (Valencia) has just invited tenders for the concession for the electric lighting of the town during a period of five years.

HOLLAND.—The Société Electra, of Amsterdam, has recently increased the capacity of its plant. Five generators are now installed of a total capacity of 3,800 H.P. There are connected up to the mains of the Société 48,720 16-C.P. lamps, and 60 motors totalling 277 H.P.

FRANCE.—Montaret (Isere) is to be lighted by electricity, and the municipality is now inviting tenders for the erection of overhead mains.

Eastbourne.—During Saturday evening last the Eastbourne parades were practically in darkness owing to the failure of the electric light, and a number of streets in the town also suffered in a like manner. On the same evening in the previous week there was a similar occurrence, and it was then stated that a fuse in the mains was the cause of the trouble.

Festiniog.—The formal switching-on of the new electric plant at the Oakeley Quarries, Festiniog, took place on Wednesday last week, the ceremony being performed by Mr. W. Edward Oakeley, the chairman. The installation has a capacity of 1,930 H.P. The energy is supplied from the Cwm Dyli station of the North Wales Power Distribution Co. and transmitted to the quarries by an aerial transmission line, being stepped down at the quarries from 10,000 volts to 500 volts.

India.—A conference consisting of his Excellency the Commander-in-Chief and other high officials, assisted by the Electrical Adviser to the Government of India, commenced sittings on July 30th last at Simla, to investigate the question of the supply of electric power to Cantonments in Upper India. *Indian Engineering* says that it is not known what the views of the conference or of the Government are on the subject of the agency to be employed for this purpose, but it is to be trusted that private firms will be employed and that it is not intended that the Government should provide its own installations.

Indian papers seem never to miss an opportunity to "get one in" on the Calcutta Electric Supply Corporation. The company is not at all popular, judging by what we gather from these papers. An application from Messrs. Killick, Nixon & Co. and Messrs. John Fleming & Co., both of Bombay, for a licence to supply electrical energy in bulk for all purposes, except lighting, in the Hooghly River district—excluding such portions as lie within the municipal area of Calcutta and Howrah—is now before the Government. Our contemporary, *Indian Engineering*, remarks that the Supply Corporation will, no doubt, be much concerned, but that it has not much to complain about. A little healthy competition will materially benefit consumers.

Lancashire.—A trade correspondent says that an important amalgamation of colliery properties is now pending in the Wigan district, and following upon this combine some important electrical developments will be carried out, it being proposed to put down elaborate installations for ventilation and other purposes at several of the collieries which are to be taken over.

Motherwell.—The following figures show the results, in brief, of the past year's working of the burgh electricity undertaking, as compared with the previous year:—

Year ended May 15th	1906.	1905.
Total revenue	£9,265	£7,452
Total working costs	3,938	2,934
Gross profit	5,327	4,518
Interest	2,040	1,885
Sinking fund	2,100	2,000
Net profit	1,187	633
Capital expended	£66,904	£62,234
Number of public lamps	60 arcs / 645 inc.	60 arcs / 624 inc.
Units sold	1,168,038	730,177
Maximum load	643 KW.	535 KW.

Ossett.—The T.C. has again approached the L.G.B. relative to the refusal of a loan of £3,500 for the establishment of electricity works, asking for the decision to be reconsidered. The L.G.B. has replied that it cannot regard the additional information—the prospect of electric tramways between Dewsbury and Ossett—as being sufficient to cause the Board to alter its previous decision. It will be remembered that the L.G.B. refused the loan on the ground that a demand for energy had not been proved, and that the scheme would be unremunerative for some years.

Pudsey.—A L.G.B. inquiry was held on August 21st relative to the application of the T.C. for a loan of £2,000 for E.L. purposes, viz., transforming station, £917; extensions, £750; incidentals, £333. There was no opposition.

South Africa.—The Rand.—The *Financial Times* of Thursday last week published an article from its Johannesburg correspondent dealing with the Victoria Falls Power Scheme. He states that the scheme has been the topic of much discussion among Rand engineers of late. The promoters of both the Victoria Falls scheme and the Vereeniging power scheme have notified their intention to apply for a private Ordinance, but, it is understood, that the Legislative Council is adverse to appointing a Select Committee, as it is considered that some highly contentious matter is involved. It has, therefore, been decided to defer such questions to the deliberations of a Responsible Assembly. Some detailed opinions of electrical engineers on the spot are contained in the article. The question of interest and depreciation on the heavy capital cost and plant respectively is touched upon, and it is pointed out that it is hard to see, even for an optimist, where the requirements for electrical energy can be found which would justify such a huge undertaking. The correspondent says, though he takes no responsibility for the views enumerated, he is reasonably satisfied that on technical grounds the figures put forward are justified. He doubts whether there can be anything like the demand for energy which would be necessary to provide reasonable expectation of profit unless, indeed, the Rand were to scrap its present steam plants. He is informed that it would not pay to do that unless energy could be supplied with guaranteed regularity at under ½d. per unit.

Warrington.—The result of the past year's working of the Corporation E.L. undertaking is as follows. We give comparative figures for 1905-6 :—

Year ended March 31st,	1906.		1905.
Total revenue	£14,608		£12,550
Total working costs	6,698		6,044
Gross profit	7,910		6,506
Interest received	59	Income-tax	224
Interest on loans	2,715		2,461
Sinking fund	2,490		2,276
Net profit	2,763		1,544
Capital expended	£81,418		£78,323
No. of 8-c.p. lamps (excluding tramways)	43,040		38,476
Units sold (excluding tramways)	1,437,740		987,562
Maximum load	1,038 kw.		993 kw.

The net profit of £2,763 has been transferred to reserve fund, bringing the total to the credit of that account up to £4,435. The increased profit is very satisfactory when account is taken of the reductions made in the prices charged for energy for lighting and power. A chart is given in this year's statement of accounts, from which it can be seen at a glance that the energy generated has each year on the average increased by about 500,000 units. The units used for traction purposes were 557,169, being an increase of 62,275 on the previous year.

Worsley Hall.—The extensive stud farm of Viscount Brackley, at Worsley Hall, near Manchester, has just been equipped with an electric lighting installation.

TRAMWAY and RAILWAY NOTES.

Acton.—Last week one of the L.U.T. Co.'s cars took fire when opposite the public library, owing to the fusing of a cable. It is stated that the flames spread to the front of the car, and did considerable damage before they could be put out.

Bath.—The B. of T. has confirmed the following order, made by the Light Railway Commissioners :—Bath Electric Tramways (Light Railway Extensions) Order, 1906, authorising the construction of light railways in the rural district of Keynsham, Somerset, being an extension of the existing and authorised undertaking of the company.

Blackpool.—An inquest was held on Saturday concerning the death of Wm. Nicholson, ironfounders' pensioner, of Openshaw, who was knocked down and killed by a Blackpool Corporation tramcar on Friday. It was stated in evidence that the driver frequently rang the bell and shouted. The driver said the umbrella which the deceased carried, got under the life guard and dragged him with it. The jury returned a verdict of "Accidental death," exonerating the driver from blame.

Bury.—The Corporation Tramways Committee has decided to recognise the trade union.

Canada.—Quebec.—The Quebec Railway, Light and Power Co., finding its present power supply somewhat inadequate at certain times, has commenced extensive developments half a mile from its present station, higher up the St. Lawrence River. To provide for the season of low water, the company has erected there, to the plans of Mr. E. A. Evans, their chief engineer and manager, a dam 84 ft. high, the highest in Canada for such a purpose. It is 67 ft. 4 in. wide at the base, and 12 ft. wide at the crest, and will hold back 52,000,000 cb. ft. of water. The plant to develop this water-power will consist of a 1,500-kw. alternator driven by a 2,225-h.p. turbine. The contract for the plant has been awarded to the Allis-Chalmers-Bullock, Ltd., Montreal. The plant is expected to be in operation by December 1st next.

Chatham.—Having been inspected the day previous by Major Pringle, R.E., on behalf of the B. of T., the extension of the Chatham and District Light Railway Co.'s system to Rainham was opened to the public on Saturday last. The line is single track, and a little over 3½ miles long. The route is along the Rainham Road as far as Rainham Mark, and then turning to the left it cuts through the hedge and runs parallel with the road until close to the village. This makes the third extension of the Chatham tramways since their opening in August, 1902. The contractors were the B.T.-H. Co.

Continental Notes.—Italy. — The Public Works Department of Bologno and Florence has given favourable consideration to a project for the construction of new lines and the prolongation of the existing tramways of Bologno. The same department has also passed plans to systematise and increase the tramway network of Florence.

A new electric tramway between Como and Chiasso was recently inaugurated by the Mayor of Como.

The Town Council of Bergamo has unanimously decided to municipalise the electric tramway and the funicular railway of the town.

Germany.—Plans are being prepared in respect of a projected electric tramway between Solingen, Krahenhohe and Mungsten.

Cork.—The *Railway Times* says that in connection with the G.W. and G.S. & W. Railway Companies' new South of Ireland service, a connecting link at Cork between the systems of the G.S. & W. and the Cork, Bandon and South Coast Railway Companies, by bridges over the River Lee, is included, thus affording direct communication between Fishguard and Rosslare and the chief centres in the south of Ireland, and the most important quays in the city of Cork. The lines will be operated by electric traction, and the Great Western Railway Co. is financially interested in the scheme.

Glasgow.—The Tramways Committee has had before it a report by Mr. James Dalrymple, the general manager, on extensions, as follows :—

The Corporation has already approved of the proposal to extend the tramway from Main Street, Rutherglen, to the junction of the Burnside Road and East Kilbride Road—length almost a mile.

The T.C. of Partick has now agreed to give its sanction to the application of the Corporation to lay a line of tramway from Byres Road to Clarence Drive—length about half a mile.

In regard to Crow Road, the Partick T.C. has approached the Committee regarding this extension (which was included in the order of last year, and withdrawn because of the position taken up by the T.C.). Mr. Dalrymple thinks the Committee should agree to again include it in the next order, and if it is agreed to go on with this extension, he would suggest that powers should be obtained to extend the tramways all the way to Anniesland. The total length of Crow Road is 1½ miles.

The extension from Maryhill to Killermont, which was opened on April 13th last, Mr. Dalrymple urges should be extended to Canniesburn ; length about half a mile.

Mr. Dalrymple thinks the time has now arrived when the Committee should consider the advisability of providing an alternative route from Eglinton Toll—*i.e.*, to make a tramway from Pollokshaws Road, along Abbotsford Place and South Portland Street ; to build a new steel bridge over the Clyde connecting South Portland Street and Dixon Street ; and to carry the line up Dixon Street into St. Enoch Square. Mr. Dalrymple does not think there would be any engineering difficulties in carrying out such a scheme. The total distance, including the bridge, measures nearly one mile. The total length of these suggested extensions is about 4½ miles of double track. All the other extensions that have been proposed are in the hands of the county authorities. These extensions are :—Coatbridge, Millerston, Busby, Newton-Mearns, Barrhead, Duntocher, Bearsden, Milngavie and Kirkintilloch.

The Committee has recommended that, in the meantime, the report be approved in so far as it relates to extensions of tramways under the headings "Cathkin Park" and "Highburgh Road," and that further consideration of the remaining portions of the report be delayed.

Halifax.—As the Tramways Committee has refused to reinstate motorman Chadwick, who was concerned in the accident last month, a ballot on the question of a strike has been taken among the men, and it is announced that only nine voted against it. Notices were to be handed in to take effect to-day. An annual holiday with pay, and a revised wages scale, are also demanded. The men will be supported by their union.

Harborne.—A wide-spread movement is on foot to induce the Birmingham City Council to provide the district with tramway facilities as soon as possible. The lack of railway facilities, the slow horse-omnibus service and the failure of the motor-'bus have contributed to the above.

Leyton.—The U.D.C. electric tramways were opened on 27th inst., the routes being High Road, Leytonstone, and Whipp's Cross to Epping Forest.

London.—Baker Street-Waterloo Railway.—On Saturday last a train ran off the track between Piccadilly Circus and Trafalgar Square, and somewhat damaged the permanent way. The Tube was at once closed down, and a breakdown gang, working all night, got a new line down by 10 a.m. on Sunday morning.

L.C.C.—Three more car drivers were summoned for exceeding the statutory speed limits, and fined on Tuesday last.

Keighley.—The Tramway Committee is anxious to secure powers to run a service of motor-'buses within the borough and surrounding districts; extensions to the electric tramways are also proposed.

Manchester.—The projected new South Manchester Railway, which is to give access to the Ship Canal Docks, will, it is stated, be equipped on the overhead system. The proposed route is from Trafford Park across to Croft's Bank, then southward to Minston, and across the Cheshire Lines Railway and the River Mersey to Ashton-on-Mersey, then on to Baguley and Hale, and along the valley of the River Bollin to Wilmslow, the present intended southern terminus. The total length of the proposed line is about 14 miles.

Newcastle-on-Tyne.—On the question of depreciation, the auditor has reported that there is an urgent necessity for a further provision for depreciation than that calculated on the terms allowed for the repayment of loans, which are longer than the probable life of the assets. In the course of his audit he discussed this important question with Mr. E. Hatton, the engineer and general manager. The result of the auditor's calculation shows that from December 16th, 1901, the date on which the tramways commenced to run, up to March 31st last, a period of four years and three months, the additional provision should have been £71,850. The reserve account now amounts to £128,173, but the auditor says that in Mr. Hatton's opinion it should be £189,127, or £60,954 more, against which there is a surplus on the revenue account of £18,704. It is therefore apparent, he adds, that there is a deficiency of £42,250 on this reserve account that should be made good. Mr. Hatton in some subsequent remarks says that the sum of £19,500 should be annually laid aside for the reserve and renewals fund, and that until the deficiency pointed out has been made good, all the surplus should be devoted to that purpose.

New Malden.—The London United Tramways Co., in refusing to share the cost (some £6,000) of reconstructing a railway bridge over the company's lines, have pointed out that they have already paid the local Council £1,600 for various purposes.

Swansea.—Recently the Corporation decided to take the necessary steps for the compulsory acquisition, under the Tramways Act, of the Alexandra Road and Mount Street section of the local tramways from the tramways company. It, however, transpires that instead of determining the intervals of 21 years, at the end of which it is competent for the Corporation to exercise its compulsory power of purchase, from the date of authorisation, the Corporation reckoned from the date of completion, and a letter has been received from the B. of T. to the effect that it cannot now proceed with the purchase of this particular section till 1910, or seven years after the lapse of the original 21 years dating from the date of authorisation. It is, however, open for it to deal at once with the Morriston section to the Hafod.

Sydney (N.S.W.).—Owing to various statements having been made to the effect that the Westinghouse-Newell magnetic brakes on the Sydney tramcars frequently failed and were inefficient, the Railway Commissioners appointed a Board of experts to inquire into the allegations. The result was that the latter were found to emanate entirely from men who had not had practical experience of the working of the brakes, and to be without foundation in fact. Tests were carried out by the Board on cars fitted with the magnetic brake, under various conditions, and 66 cases of reported failures which occurred between the introduction of the brake in January, 1905, and July 15th, 1906, were investigated; it was found that the cars fitted with air brakes ran on the average 8,570 miles for each brake trouble, as compared with 17,133 miles in the case of the cars fitted with the magnetic brakes, though the latter were working on the severest grades. The report of the Board concludes with an expression of confidence in the efficiency of the magnetic brake.

Teddington.—The U.D.C. has decided to urge upon the L.U.T., Ltd., to lessen the noise caused by their cars; to insist on the widening of Stanley Road as originally agreed; and further to call the attention of the B. of T. to the condition of the track. The Council has further decided to ask the Commissioner of Police to enforce the by-laws as to the speed of the cars through the town.

TELEGRAPH and TELEPHONE NOTES.

Canada.—The Stark Telephone, Light and Power Co., of Toronto, has approached the Niagara Falls, Ontario, municipal authorities with a view to securing rights to enable the company to operate at Niagara Falls. It offers the town in return a free fire-alarm system, 10 city telephones free, a house rate of $18 and office rate of $36 per annum, or $6 a year for house and 1 cent for each outgoing message. It will put in an automatic call system, have no party lines, and wants to use the municipal poles when practicable. A municipal committee and the company's electrical representative have arranged to meet shortly to discuss the proposition.

(Continued on page 343.)

THE SEMENZA PORCELAIN INSULATOR AT THE MILAN EXHIBITION.

The advanced position now held by Italian engineers in the field of electric transmission is again shown, by the new porcelain insulator exhibited in the kiosk of Messrs. Richard-Ginori in the Milan Exhibition.

All insulators now manufactured must be made sufficiently large to stand the electrical and mechanical strain under all atmospheric conditions, and one of the worst of these conditions met with in practice is the case of severe rain storms.

To guard against this rain trouble, it has been usual up to the present time to make the upper petticoat with a very large diameter to enable it to protect the lower part of the insulator, whose surface, being thus kept dry, would offer the necessary resistance even during severe rain storms.

A sectional view of an ordinary insulator is shown in fig. 1, this being a type frequently used in Italy, in which the wire is fastened to a "head" forming one piece with the upper petticoat.

This necessitated making the whole of this petticoat of the same insulating material, which formed the chief part of the insulator, and it had to be made with just as much care as the lower petticoats.

The recent tendency to increase the working pressures, and the resulting greater distance which must be maintained through the air between the "live wire" and the grounded support, made it necessary to correspondingly increase the

Fig. 1.

Fig. 2.

diameter of the upper petticoats, which resulted in a great increase in cost.

Signor Guido Semenza, the well-known Italian consulting engineer, and Hon. Secretary of the Italian Electrotechnical Association, devised the type of insulator, of which a section is shown in fig. 2, and the final details have been perfected by the engineers of the Societa Ceramica Richard-Ginori, after a large number of experimental trials made in the electrical testing laboratory connected with the works of the company at Doccia, near Florence.

It will be seen that in the Semenza insulator the wire is fastened below the upper petticoat. It is, therefore, unnecessary for this petticoat to be strong enough to resist perforation. It need only be watertight and sufficiently hard to resist mechanical shocks and rough usage in transportation. It is therefore made of a form of terra cotta which is neither so costly nor so breakable as porcelain or glass.

Since the point of attachment of the wire in the Semenza type is somewhat lower than in the old type, the "strain moment" of the wire is greatly reduced, which enables a reduction to be made in the thickness of the insulator and in the diameter and cost of the iron bolt; and since this upper petticoat or umbrella is not connected in any way with the pin, complications due to increased capacity are avoided.

The great improvement and the advance of this insulator over the old types is well illustrated in fig. 3, which shows a comparative test made between the old and the new pattern. Reference to the figure will show that a common wire connects the "heads" of the two insulators; this is led to one terminal of the transformer, the other terminal being placed in the alkali bath in which the pins are supported. The

breakdown under the conditions shown above, was at 76,000 volts under a rainfall of 1,600 millimetres (62 in.) per hour. The difference in size between the two insulators for the same breakdown is very clearly shown below.

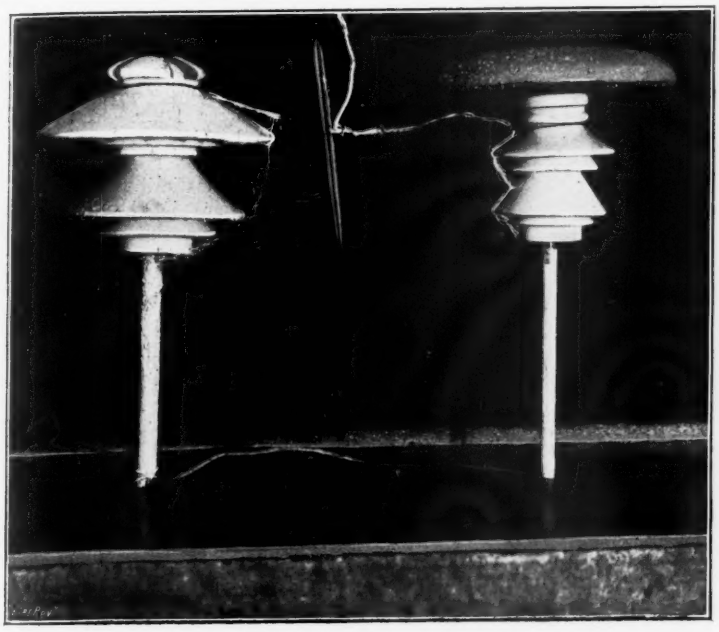


Fig. 3.—Comparative Test of Old Type and Semenza Patent Insulators.

Fig. 4 shows the new Semenza insulator under an electric pressure of 122,000 volts, the test being taken with the insulator dry. The length of the discharge which takes place between the needle point and the surface of the alkaline bath is shown by the scale, which also serves to give some idea of the dimensions of the new insulator.

It is claimed that tests with a driving rain do not make any difference in the remarkable results shown by these experiments, and if such difficulty were anticipated, the size of the umbrella could be correspondingly increased with practically no difference in price.

The manufacturers state that they cannot at present give the exact dimensions of an insulator of the old style corresponding to that represented in fig. 4, as this insulator will resist a strain of 111,000 volts under a rainfall of 1,200 millimetres (46 in.) per hour, which in the old type, they claim, has not yet been manufactured. They also point out that if the difficulties of manufacturing such an insulator could be overcome, it would have at least double the price of the Semenza patent insulator.

The saving in price between the Semenza insulator and one of the old type is stated to be between 30 and 40 per cent. for an equally safe installation for working pressures between 35,000 and 50,000 volts, and for working pressures of 80,000 to 90,000 volts, a saving of 50 per cent. is claimed.

Reference to fig. 3 will show that the surface of the insulator is covered with moisture, and that drops of water actually collect there; tests, however, seem to indicate that the good results are not affected by heavy films of moisture.

Signor Semenza has stated that he considers one of the reasons for the remarkable results achieved to be that the wire is at no point in touch with a stream of water running over the surface of one of the effective petticoats of the insulator, and it might, perhaps, be said that the important effect of the insulator seems to be that the live wire and the effective surface of the upper petticoat are screened from "live water."

The shape of the umbrella might, of course, be slightly altered if necessary to cause the stream of water to run off on either side of the insulator entirely clear of the live wire.

It is interesting to note that tests so far undertaken seem to indicate that with this type of insulator the breakdown point under the heaviest rain storms is only in the neighbourhood of 90 per cent. when wet, as compared with the breakdown when dry.

In conclusion, it should be stated that this insulator is now being placed on actual transmission lines, and the results obtained in practical operation should be awaited with great interest by those engaged in transmission line problems.

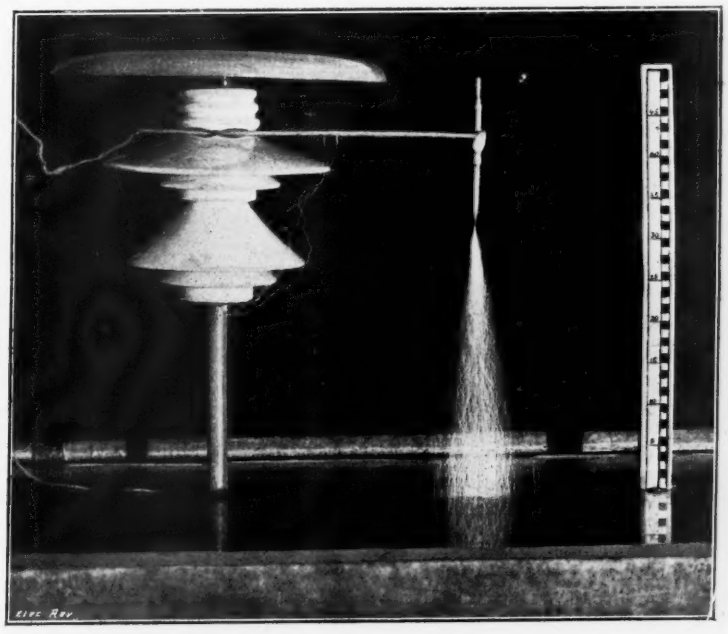


Fig. 4.—Semenza Patent Insulator under 122,000-volt Test.

ELECTRIC AUTO-CARS ON THE NORTH-EASTERN RAILWAY.

The trials of electric auto-cars on the North-Eastern Railway have proved very satisfactory, and as considerable technical interest attaches to this method of locomotion and the particular type of car adopted by the North-Eastern Railway, a detailed description of one of the vehicles will be apposite, and of some value to electrical engineers.

Of the ordinary bogie saloon type, with clerestory roof, the car measures 52 ft. over headstocks, with an inside width of 7 ft. 11 in. It is divided into three compartments, of which that at the forward end contains the petrol motor and generator; between this and the centre or passenger portion is a gangway to permit of entrance to either the engine or passenger compartments; the rear compartment contains the machinery for operating the car from that end.

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The engine compartment is 13 ft. 3 in. long, and contains an 80-B.H.P. four-cylinder horizontal petrol motor, built by the Wolseley Tool & Motor Car Co., Adderley Park, Birmingham. The cylinders are 8½ in. in dia. × 10 in. stroke, and the normal speed is 420 r.p.m., which can be increased to 480 revs. for starting the car quickly. The cylinders are overhung on a stiffly constructed cast-iron crank chamber, the inspection covers being on the top and the oil trough beneath; forced lubrication is used for all the main bearings. The fly-wheel, which is truly balanced, is 3 ft. in dia.; all the valves are mechanically operated by cams on two cam shafts, and the latter are driven by means of gearing and lay-shafts from the crankshaft. The crankshaft is two-throw, and of Vickers-Maxim cast-steel. The engine cylinders and valve boxes are water-cooled, a Clarkson radiator and Blackman fan being employed for the cooling of the water.

Interior of North-Eastern Petrol-Electric Auto-Car.

The engine is governed on the throttle, and in addition, auxiliary hand throttling is fitted so that the driver can accelerate the engine speed from either end of the car. The ignition is by means of the usual high-tension system. The engine is direct-coupled to a separately excited compound wound direct-current generator of 55 KW. capacity, specially designed for operating over a range of voltage from 300 to 550, and supported on an extended bedplate.

The upper half of the magnet ring may be removed for access to the armature or field coils, through an opening in the roof of the car, fitted with a removable cover. The exciter is a 3·75-KW. standard 72-volt shunt-wound belt-driven multipolar generator, mounted above the main generator and driven from the extended shaft. This machine is capable of exciting the main generator and of supplying energy for lighting 30 72-volt 16-C.P. incandescent lamps. The pressure of the machine may be increased to 95 volts for charging the battery, when not required for lighting.

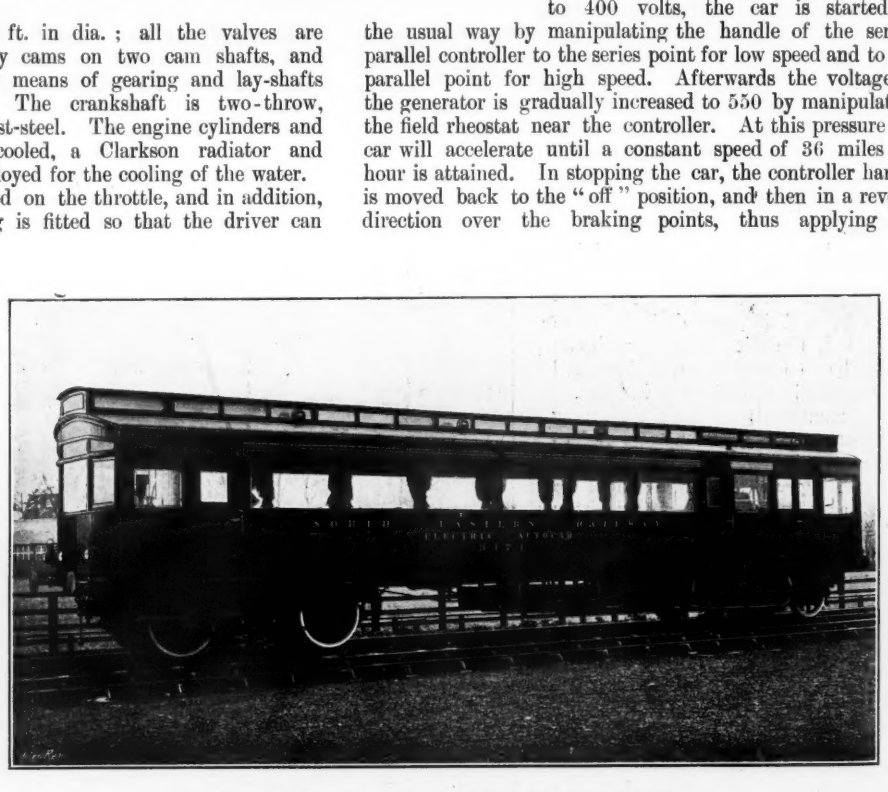
Two Westinghouse No. 56 55-H.P. standard series wound railway motors with single reduction gears, ratio 18 to 64, are mounted on the front bogie by means of a nose suspension bar with spring attached to the bogie frame; the controllers are of the standard series-parallel tramway type arranged for electric braking.

The storage battery consists of 38 cells in ebonite jars, carried in a wooden box suspended beneath the car, and has a capacity of 120 ampere-hours.

The brake equipment is of the Newell magnetic type, fixed to each truck.

On the rear bogie is located an air compressor which supplies air for blowing an alarm whistle. It is driven by a 1-H.P. electric motor and is started and stopped by means of pressure-controlling switches and cut-outs, thus automatically maintaining a constant pressure in the air reservoir which supplies the whistle. The whole of the electric equipment has been supplied by the British Westinghouse Electric and Manufacturing Co., Ltd., of Old Trafford, Manchester.

The system of working may be briefly described as follows:—Energy passes from the generator through an automatic circuit-breaker to the two controllers, and the voltage of the generator is adjusted by means of a rheostat in the field circuit placed near the controller at each end of the car. The generator is used as a motor supplied with energy from the battery for starting up the the petrol engine. After bringing the engine and generator up to speed and adjusting the pressure to 400 volts, the car is started in the usual way by manipulating the handle of the series-parallel controller to the series point for low speed and to the parallel point for high speed. Afterwards the voltage of the generator is gradually increased to 550 by manipulating the field rheostat near the controller. At this pressure the car will accelerate until a constant speed of 36 miles per hour is attained. In stopping the car, the controller handle is moved back to the "off" position, and then in a reverse direction over the braking points, thus applying the magnetic track brake. As soon as the car is brought to a standstill, the generator field rheostat is readjusted to give 400 volts, and it is then in a position for restarting. If it is desired to drive the car at half-speed, the pressure may be raised to 550 volts by adjustment of the rheostat with the controller handle at the full series point. It will be seen from this that a range of speed is obtainable by variation in the voltage of the generator at two points—approximately half-speed and at full-speed. The cars can be put into service at 10 minutes' notice, and they carry a supply of both

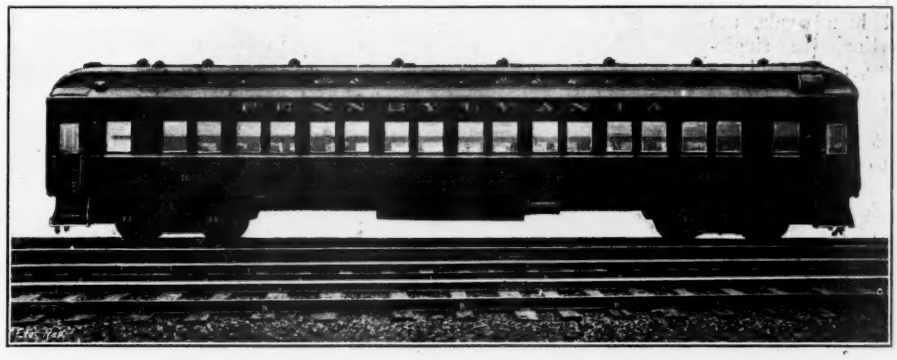


Petrol-Electric Auto-Car, North-Eastern Railway.

fuel and water for a full day's work, and can be driven from either end with equal facility. Each car in full working order weighs 35 tons.

The passenger portion is furnished with two rows of reversible seats, upholstered in the company's usual style and affording accommodation for 52 passengers. The lighting is by means of 24 16-c.p. incandescent lamps, energy being supplied from accumulators carried under the centre of the car, and the head and rear lights are electrically fitted. The car is efficiently heated for winter use by a series of radiators, which can be shut off during the summer months, and altogether it is very cosily arranged for the comfort of passengers.

For the opportunity of inspecting and describing these petrol electric autocars, we are indebted to the courtesy of Mr. Vincent Raven, assistant mechanical engineer of the North-Eastern Railway.



All-Steel Car, Pennsylvania Railway.

AMERICAN STEEL CARS.

The Pennsylvania Railroad in America has, within the past month, decided to place about 1,000 all-steel fireproof passenger cars in service when its New York tunnel is completed; the company also intends to acquire some 500 Pullman cars of similar construction.

The above decision was come to after careful trial of an experimental coach, No. 1,651, said to be "the first all-steel passenger car," views of which are given herewith. The new cars weigh 103,550 lb. each, as compared with 84,900 lb. for the standard wooden coach; some of the additional weight, however, is due to an equipment of storage batteries, the Pennsylvania Co. having decided to eliminate gas-illuminated cars from its New York tunnel.

Interior of Steel Car, Pennsylvania Railway.

With a view to avoiding telescoping in the case of collision, the frame floor of the car is built of steel girders, a central box girder some 24 in. × 19 in., which extends throughout the length of the coach, being a special feature. The door and vestibule end posts are also of heavy rolled steel.

The question of steel fireproof construction, especially for electric tunnel railways, is one which a British railway, the Central London to wit, successfully solved some three years ago, and with which British car builders have shown themselves eminently capable of dealing; the details here given of our American friends' initial venture in a similar direction, for which we are indebted to Messrs. Parker & Lee, of New York, are interesting by way of comparison with what has been accomplished in this country.

THE SPOKANE AND INLAND RAILWAY.

Some months ago announcement was made of a new single-phase railway which was projected to run between Spokane, Wash., U.S.A., and several neighbouring cities; since that time the general plans of the system have been completed, contracts for the equipment let, and the construction work practically finished. As this installation embodies a number of entirely new features in electric railway work, an outline of some of its importan characteristics will be of interest at this time.

The railway was originally incorporated under the name of the Spokane Inter-urban System, with a capital of $3,500,000, the incorporators being well-known local capitalists. The principal terminal of the road is Spokane, from which town the line runs south through Waverly, Rosalia, Thornton and Colfax, which is the southern terminus at present, although the road has been surveyed, and will be eventually extended to Penawawa, Wash., or Lewiston, Idaho. A branch leaves the main road approximately midway between Spokane and Colfax, and extends to Palouse City. The Y-connected system between Spokane, Colfax and Palouse City is about 106 miles in length. The track work and overhead construction has already been completed.

In addition to its railway business, the company proposes to transmit and distribute electrical energy for lighting and power, both in the city of Spokane and in the towns through which its lines pass. The country traversed produces large quantities of wheat and fruit, and is not provided with any railway transportation. This ensures a large freight business for the line, as the long journey to the steam railway routes will be avoided. For this reason the electric

line is receiving the hearty support of the farming interests along its route.

There are three classes of service to be maintained—passenger, mail and express, and freight; and after a careful consideration of the various systems had been made, the Westinghouse single-phase, alternating-current system was adopted as being the most economical in first cost, as well as in operating expenses, besides permitting the use of locomotives for a system of heavy traction, which would have been impracticable with a direct-current system. The cars of the Spokane and Inland Railway enter the city over the tracks of the Spokane Traction Co., which operates a 600-volt direct-current system, and this requires the use of both direct and alternating-current on the inter-urban cars.

Electric Locomotive, showing Trolley for Low Pressure Working.

Power is purchased from the Washington Water Power Co. for the operation of this line. It is delivered as 4,000-volt, three-phase current of 60 cycles, to a frequency-changing station about 10 miles south of Spokane. This station will contain four motor-generator or frequency-changing sets, each of a normal rating of 1,000 KW., and consisting of a 1,000-H.P., 60-cycle, three-phase, 4,000-volt induction motor, a 1,000-KW., 25-cycle, 2,200-volt, single-phase alternator of the revolving field type, and a 750-H.P., 550-volt direct-current generator which is to float on a storage battery, acting alternately as a motor and as a generator. These three machines will be mounted upon a single bed-plate. There are three exciter sets for the alternators, each consisting of a 75-H.P. three-phase 4,000-volt induction motor and a 50-KW. direct-current generator. A 20-panel switchboard, electrically-operated oil circuit-breakers and lightning arresters complete the equipment of the frequency-changing station.

Electric Locomotive, showing Pantograph Collector for H.T. Single-Phase Working.

The 2,200-volt 25-cycle current is stepped up to 45,000 volts by means of four 1,250-KW. oil-insulated water-cooled transformers, and at this pressure is transmitted to 15 transformer sub-stations. Each sub-station is equipped with two 375-KW. transformers of the oil-insulated self-cooling type, which step down the current from 45,000 volts to 6,600 volts, the trolley line voltage. The cars and locomotives operate under three different pressures; 6,600 volts alternating current in the country, 700 volts alternating current in the small towns, and 600 volts direct current in the city of Spokane.

The trolley line is of the Westinghouse standard catenary construction with a No. 000 wire. The high tension transmission lines are No. 2 copper wires.

The electrical equipment of both the passenger and the express cars is identical, and consists of four Westinghouse 100-H.P. alternating-current railway motors per car, which will maintain a schedule speed of from 35 to 40 m.p.h. The locomotives are equipped with the same type of motors,

but the latter are each of 150 H.P. capacity. Both the motor-cars and the locomotives are operated on the Westinghouse multiple-unit control system.

These locomotives are designed to handle a general goods traffic, and each of them is capable of hauling seven standard freight cars, fully loaded, at about 30 miles per hour on a level track. They will operate on the 6,600-volt and 700-volt alternating-current lines and on the 600-volt direct current line. Both pantograph and wheel trolleys are used, as shown in the accompanying illustrations, the pantograph trolley being for operation on the 6,600-volt circuit and the wheel trolley on the 700-volt A.C. and the 600-volt D.C. circuits.

The cab of the locomotive serves to enclose the auxiliary apparatus, and is constructed entirely of steel. The total weight of the locomotive is 49 tons, and its length over buffers is 29 ft. It has two swivel trucks with 38-in. driving wheels, and two motors are mounted on each truck and are geared to the axles. Both "straight" and automatic air brakes are used, the compressed air for which is supplied by two Westinghouse Air Brake Co. compressors, each driven by a 5-H.P. Westinghouse single-phase motor.

The four traction motors are arranged in two groups, each consisting of two motors connected permanently in series; so for the purpose of control these groups may be considered as single units in a two-motor equipment. Two auto-transformers are used on the locomotives, and an automatic circuit-breaker is placed between the trolley and the transformers, which operates on either overload or no-voltage by breaking the current supply to the control magnets, thus automatically opening all the switches. This circuit-breaker must always be closed by hand, and it will not remain closed unless the trolley is up and the current is on the line.

When the circuit-breaker is thrown in, the circuit is completed through the auto-transformers to earth. A commutating switch is automatically shifted to the A.C. position, and the small transformer furnishing current to the control system is cut into circuit, leaving the locomotive ready to start.

The unit switches are essentially similar to those used on direct-current systems. The control magnets are of the A.C. type, wound for 200 volts, and operate on about 80 volts D.C., but in both cases they will operate down to about one-half the normal voltage. These serve to admit air under heavy pressure to the cylinders which operate the unit switches. These switches are assembled into a compact unit known as a switch group, and the group is protected by an iron case, in which it is mounted, from the severe exposure to which a locomotive or street car equipment is subject.

Interlock contact blocks are provided, which make it impossible for any switch to close or remain closed unless all the other switches operate according to their predetermined cycle. This assures the proper order of switch operation.

The alternating current for the operation of the magnet by the master controller is obtained from the secondary of a small transformer, which is connected to the 500-volt point of the main auto-transformer. When operating on direct current a resistance is placed in series with this auxiliary transformer across the 600-volt mains, and direct current is taken from a suitable tap on this resistance. This dispenses with the use of a storage battery for direct-current operation.

The only mechanical operation in changing from alternating current to direct current is to change the trolleys; the control is changed automatically by the commutating switch, which is a small pneumatically operated drum for shifting the control circuits. This drum is operated by a magnet connected directly to a 200-volt tap on the main auto-transformer, and has no direct-current connection. The switch has one position for direct-current operation and another for alternating-current operation, and it cannot be thrown to the A.C. position unless alternating current is flowing through the magnet coil. If it should remain in the D.C. position no harm would be done.

The reversing switch is similar to the commutator switch in its operation, but is furnished with two magnets and air cylinders, one for each position.

The preliminary order on this contract provided for 15 passenger motor-cars, 6 express motor-cars and 6 locomotives. Trailer cars are also used, the standard passenger train consisting of two motor-cars and one trailer.

TELEGRAPH and TELEPHONE NOTES.

(*Concluded from page* 338.)

Bulgaria.—The *Bolletino delle Finanze*, &c., reports that a wireless telegraph station is to be installed at Varna to communicate with Italy *vid* Antivari and Bari.

Colombia.—The United States Consul at Barranquilla reports that a concession for cable construction has been granted by the Colombian Government to Francisco J. Fernandez. Cables have now to be sent overland on the National Telegraph lines to Buenaventura, on the Pacific side, *vid* Bogota, a distance of nearly 1,500 miles. This is not only very expensive, but extremely uncertain, and frequently involves delays of from three to five days. In fact, the safest and quickest way to send a cable is by mail to Colon, Port Limon, or the West Indies to be dispatched therefrom. The concession also includes the exclusive privilege of erecting wireless telegraph stations within the country of Colombia. In this respect Savanilla, the port of Barranquilla, offers unusual advantages. Stations are already established at Colon, Bocao del Toro, Port Limon, Bluefields, &c. It would be a simple matter to erect a plant to connect with these stations. The Colon and Trinidad stations are very powerful, and reach long distances. The Royal Mail steamers making weekly calls at Barranquilla are all equipped with the De Forest system, and a fair amount of marine business could be done with them. A plant of fair size, with a radius of action of not less than 600 miles, would not cost over $10,000, and the expenses of operation would be less than at the ports named, as labour is cheaper and more efficient. The Government guarantees an interest of 7 per cent. per annum on practically all the capital invested.

German Wireless Telegraph Station.—It may be interesting once again to draw attention to the gigantic station for wireless telegraphy which has been erected by the German Government at Norddeich, near Emden, on the North Sea coast. The station, which stands forth as an imposing landmark owing to its being higher than any other elevated structure which is visible in that district, attracts the special attention of visitors boarding steamers at Norddeich. At present the station has not been brought into official use, pending the completion of the experiments which are in progress. It is claimed to have a radius of action up to 930 miles, and to include almost the whole of Europe, Greenwich, Naples, and St. Petersburg being mentioned as within its scope of activity. Torpedo boat S 36 recently completed a series of trials in conjunction with the Norddeich station, and these were followed by similar tests with the cruiser *Munchen*. This small cruiser left Kiel towards the end of July for the Norwegian coast, and steamed to Drontheim, which is about 682 miles distant from Norddeich taken in a straight air line. It is stated that the trials were successful, inasmuch as it was possible to establish communication with the North Sea coast at a distance of over 620 miles. It had been intended to continue the journey to Tromsoe, but the installation on the *Munchen* was inadequate for dealing with a more remote locality. The experiments are now being resumed by the *Vineta*, which is equipped with more powerful apparatus and higher conducting masts. It is expected that the results with this warship will surpass those which have hitherto been obtained with the other two vessels.

Iceland Cable.—The opening of the cable between Thorshavn and Seydisfjord was officially announced on the 27th inst.

Italy.—The *Bolletino delle Finanze*, &c., states that the Emigration Commission proposes to present to Parliament an addition to the Emigration Bill, to provide that all emigrant vessels shall be provided with wireless telegraphic apparatus.

Leeds.—On the 25th inst. a fire took place at the principal exchange of the National Telephone Co., doing damage to the extent of £100. The employés had, fortunately, been well drilled. The female operators marched out in good order, while the men quickly extinguished the fire, which, as usual, occurred in the test-room. The service was completely restored by Monday morning.

Life of Wooden Poles.—The German Postal and Telegraph Department has recently published statistics collected during a period of 52 years on the life of wooden posts impregnated with different preservative substances. The number of posts under observation amounts to nearly 3 millions, and the following are the average results obtained:—

Poles impregnated with—	Length of life.
Sulphate of copper	11·7 years.
Corrosive sublimate	13·7 years.
Creosote	20·6 years.
Un-impregnated	7·7 years.

The manner of preparing the poles has been improved from time to time, and this is clearly shown in a further table giving the average length of life of the poles under different methods of treatment with each preservative at different periods. For example, in 1883, with sulphate of copper the average life was 9·4 years, whilst in 1903 the method of treatment had been improved so that an average life of 13·3 years could be obtained.

Natal.—During 1904 the Government telegraphs handled 2,266,697 telegrams, and in 1905 2,170,833. The total receipts from the Telegraph Department for the financial year ending June 30th, 1905, including telegraph and telephone, amounted to £71,326, of which £11,443 represents the work done for other Government departments, for which no payment is received. The increase over the previous year's revenue amounted to £1,851. The value of telephone subscriptions amounted to £6,005, as against £4,590 for the previous year. The withdrawal of the garrison at Maritzburg caused a decline in the receipts from transmission of military telegrams of £526.

The charges collected during the year by the Eastern and South African Telegraph Co. on cable messages sent to and from South Africa exceeded £300,000, and, in accordance with the terms of the agreement with the company, the annual subsidy was reduced to £85.

The following are the more important telegraph works carried out during the year: Reconstruction of main line, Mooi River to Ladysmith; erection of a new line, Eland's Kop to Donnybrook; two additional wires erected between Dundee and Newcastle, *viâ* Glencoe Junction, during the repairing of the damage caused by the storm.

New Wireless Telegraph Co.—The German Company for Wireless Telegraphy, of Berlin, which works the "Telefunken" system, has just formed the Telefunken, Ostasiatische Gesellschaft für Drahtlöse Telegraphie for the promotion of the method in the Far East from the town of Tsingtau. It is proposed not only to deal in apparatus, but also to undertake complete installations on land and sea for the area of China, Hong Kong, Manchuria, Tsingtau and Corea—all with a share capital of £5,000.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Trinidad-Demerara (No. 1.)	Aug. 26, 1901	
Dominica-Martinique	May 7, 1902	
St. Lucia-Martinique	May 7, 1902	
Reissa-Issa (Yemen) Camaran	Oct. 22, 1902	
Cayenne-Pinheiro	Aug. 13, 1902	
Port Arthur-Chifu (Closed)	Mar. 7, 1904	
Tarifa-Tangier	Jan. 18, 1904	
Garachico (Tenerif)-Santa Cruz	July 12, 1906	
Bolamo-Bissao	July 24, 1906	
Curacao-La Guayra / Curacao-Coro	Closed.. Jan. 11, 1906	
Falmouth-Bilbao	Aug. 14, 1906	
Mole St. Nicholas-Port au Prince	Aug. 16, 1906	
Communication with Chile and Peru	Aug. 16, 1906	
Landlines.		
Puerto-Barrios	Aug. 28, 1902	
Bachkale-Deliman	Feb. 12, 1906	
Bagdad-Bassorah	July 17, 1906	

Wireless Telegraphy.—According to the *Daily Mail* the War Office has recently been considering the important question of its legal rights in connection with wireless telegraphy and submarine telegraphs in the British Isles in war time.

As the result of the report of a specially appointed committee the department is about to take the necessary steps to enable a rigid censorship to be maintained—in the event of home defence being necessary—over all wireless telegraph installations and submarine cable stations in the United Kingdom and the territorial waters.

It is reported by the same paper that for experimental purposes the War Office has ordered two extensive sets of equipment from the German Wireless Telegraph Co. (Slaby-Arco system). Their Berlin correspondent states that one set is for use on wagons in the field, and the other, also portable, is meant to be moved from place to place by hand. The former type, it will be remembered, was described and illustrated in our issue of March 23rd, 1906.

The *Daily Telegraph* Paris correspondent states that wireless telegraph experiments have been conducted by army engineer officers for two years past from the Eiffel Tower. The Minister of War is now applying to the City of Paris for the lease of a plot of ground on the Champs de Mars, near the tower, whereon to build a special permanent post. The Eiffel Tower experiments have succeeded so well that the Paris headquarters are now in regular wireless communication with all the frontier forts and principal naval ports. The "Palace of Wireless Telegraphy" is to be the permanent post for these communications. In time of war the Paris headquarters' staff could thus send orders out direct all along the frontiers. Still, the correspondent adds, it must be remembered that according to most authorities, no certain means have yet been found of ensuring wireless messages against interference by a hostile force.

During the recent naval manœuvres the *Ile de Porquerolles*, off Toulon, was used for a wireless telegraph station. The island was used for the same purpose in the early days of wireless telegraphy, but was abandoned. It has just been proved that direct communication can be kept up with the Eiffel Tower in Paris, and M. Thomson, the Minister of Marine, has ordered a permanent station to be made on the island.

A new wireless station has been erected at Cullercoats, near Tynemouth, by the De Forest Wireless Telegraph Syndicate, Ltd., of Princes Street, E.C.

The Italian *Journal of Public Works* states that experiments are being conducted in the Italian Navy with a view to the dispatch and reception of wireless messages simultaneously. Up to the present it has only been possible to conduct these operations at separate intervals.

CONTRACTS OPEN and CLOSED.

OPEN.

Algeria.—The Post and Telegraph authorities have just invited tenders for the supply of 5,100 metres of telephone cable.

Dublin.—September 8th. Arc lamps and arc lamp pillars for the Corporation. See "Official Notices" August 24th.

Dublin.—September 8th. 500 A.C. meters, single and three-phase, for the Lighting Committee. See "Official Notices" to-day.

Edinburgh.—September 12th. Electrical wiring and fittings for the Police Fire Station, at Stockbridge. See "Official Notices" August 17th.

Germany.—Tenders are about to be invited by the municipal authorities of Fulda, for the establishment of a central electric lighting station in the town.

Handsworth.—September 15th. Electric wiring for the Council's new schools. See "Official Notices" August 10th.

Johannesburg.—October 15th. Tenders are required by the T.C. for single-phase alternating current motors with accessories. See "Official Notices" to-day.

Manchester.—September 6th. The Electricity Committee is prepared to receive tenders for the supply of (*a*) three 1,250-KW. rotary convertors; (*b*) high and low-tension cables; also for the supply and erection of H.T. switchboards at their substation at Gorton. Specifications and forms of tender from Mr. F. E. Hughes, Secretary, Electricity Department, Town Hall, Manchester. Sealed tenders, enclosed in the official envelope, and addressed to the Chairman of the Electricity Committee, Town Hall.

Margate.—September 3rd. The Council invites tenders for an E.L. installation at the Wingham Pumping Station. See "Official Notices" August 24th.

Oxford.—September 17th. The Corporation invites tenders for the reconstruction, extension, and electrical equipment of the existing horse tramways, and the leasing thereof. Proposals based upon the overhead system of electric tramways will not be considered. The conditions of tender may be obtained from the town clerk on deposit of Bank of England notes to value of £100. Tenders to the Town Clerk, endorsed "Tender for Tramways," delivered at Town Hall, Oxford.

Rathmines (Co. Dublin).—September 12th. The U.D.C. wants tenders for electricity supply mains, house fuse boxes, house meters, extension of switchboard, extension of accumulators, and battery booster. See "Official Notices" August 24th.

Rome.—The Mayor has published a notification that tenders are required for the construction and working of 55 km. of new tramway lines. Offers must be sent in before October 15th next.

St. Pancras.—September 5th. One 2,000-KW. steam turbo-generator, switchboard, condensing plant, &c.; two 500-KW. three-phase motors coupled to continuous-current generators, switchboards, &c., for the Borough Council. See "Official Notices" August 17th.

Stoke-upon-Trent.—September 5th. Electric wiring of workhouse premises. See "Official Notices" August 17th.

Wigan.—September 5th. The Electric Light and Tramways Committee is prepared to receive tenders for the supply of:—Cables; timber; overhead line material; electrical accessories; carbons; meters; glass; engine room stores; paint, varnish, &c.; tramcar accessories; ironmongery; motors. Specifications and forms of tender may be obtained on application to the Engineer and Manager. Endorsed tenders to the Town Clerk, King Street West, Wigan.

Zurich.—September 30th. Tenders will be opened on September 30th at the "Stadtischer Bauvorstand II." for the supply and erection of turbines and electric machinery at the municipal generating station at Zürich.—*Board of Trade Journal.*

CLOSED.

Barking.—The U.D.C. has accepted the tender of the British Electric Equipment Co., instead of that of Dick, Kerr and Co., recommended by the committee, for the overhead equipment of the tramways in East Street and Longbridge Road from Ripple Road to Fanshawe Avenue, at £279 10s. 2d.

Bolton.—The Corporation has placed orders with the British Thomson-Houston Co., of Rugby, for 10 roof-covered single-truck cars, with standard B.T.-H. double-motor equipments, Brush car bodies and Brill trucks.

Bradford.—The contract for the electric light installation and fittings at the Church Institute, Bradford, has been placed with the Bradford Electrical Engineering Co.

Handsworth.—The U.D.C. has awarded the contract for supplying and laying cables to Messrs. Johnson & Phillips, Ltd., of Charlton, Kent.

Melbourne.—An order has been placed with Messrs. Veritys, Ltd., for 64 of their "Aston-Worsley" arc lamps for public lighting.

San Paulo.—Ten trucks have been ordered for the San Paulo Tramways from the Brush Electrical Engineering Co., Ltd.

Shanghai.—The Brush Electrical Engineering Co., Ltd., has received an order for 100 car bodies and trucks for the Shanghai Tramways.

Stratford.—The Stratford Electric Supply Co. has placed an order with Messrs. Johnson & Phillips, Ltd., Charlton, for the complete installation, including gas producers and engines, dynamos, battery, switchboard, and vulcanised bitumen cables.

REVIEWS.

Experimental Electro-chemistry. By N. Monroe Hopkins, Ph.D. London: Archibald Constable & Co. 1905. Price 12s. net.

As this volume is stated by the author to be intended for use by students in lecture room and laboratory, it would perhaps be unfair to insist that what strikes the reader most forcibly on reading it, namely, its curious incompleteness in many parts, quite unfits it to be a work of reference for the ordinary reader or the chemical engineer. The author further states that the book may be read as history by the student, presenting theory and practice together. We fear that it was through the attempt to apply consistently these principles that arose most of the faults of style and treatment, the inconsequence, the scrappiness, and the incidental way in which important points of theory are introduced, as if by the merest chance, into the middle of descriptions of experimental work, and *vice versâ*, that one must regretfully refer to here. The result is a certain general looseness and superficiality, particularly in the theoretical sections, and these are grave faults in a work intended for students. Nevertheless, the book is easy and pleasant reading, especially in the descriptive portions, and great pains have been taken to make these attractive and convincing.

After a slight introductory Chapter I, chiefly of an historical character, Prof. Hopkins devotes two chapters to the dissociation theory, which he accepts as a working hypothesis in the orthodox form. A few of the links in the usual chain of evidence are explained; but these are too incomplete to satisfy the critical student. It is a pity that some of the chief objections to the original theory are not stated; such omissions are bound to encourage dogmatism. Moreover, the impression conveyed that the theory (in the old form) is now universally accepted is an entirely erroneous one, for every physico-chemist of repute now accepts some "association" or "hydrolytic" modification of Arrhenius's hypothesis. The author on p. 35 attributes the heat evolved when water freezes to the purely descriptive term "latent heat," implying that this *explains* that phenomenon, a piece of scientific scholasticism only too common nowadays, that should not be allowed to pass unnoticed. The purpose of Chapters IV and V, on "Electrolytic Induction," is mainly to prove the existence of free ions in electrolytes not conveying currents, by means of the author's elaborated form of Ostwald's classic experiment on the effect of static induction on liquids. But no opponent of the ionic hypothesis would accept these experiments as rigidly conclusive, seeing that they depend for their effect on the action of a transient current. The author on p. 56 seems to claim priority for the idea of inducing a current in a coil of electrolyte—a result that is surely a piece of universal common knowledge; it would be surprising if it were not. The elaborate and ingenious apparatus by which Prof. Hopkins proves experimentally that "an electrolyte conducts the electric current as quickly as a non-inductive conductor of the first class of the same resistance" is here described for the first time; here again, however, we are not convinced by the reasoning which deduces from the above experimental fact the existence of free ions in electrolytes. The sub-heading of Chapter V, "Experiments with a High-speed Special Chronograph Capable of Dividing a Second into a Million Parts," would be more in place on the poster of a halfpenny evening paper than in a serious scientific work. On p. 93, in Chapter IV, that on Faraday's Law, another curious claim of priority occurs: "Although glass is always stated to be the best electric insulator known, it occurred to the writer that its constituents could carry the electric current if the ions were only free to migrate. In other words, glass was regarded by the writer as being a solid electrolyte." Chapter VII deals with the energy required in electrolysis, and the electrolysis of a fused chloride is taken as an illustrative example of the application of the energy equation. Then, on p. 107, the author suggests taking the case of a non-igneous electrolyte, and calculating the minimum voltage required, but he soon gets led away into side issues, and nothing further is heard of minimum voltages. This instance is quoted merely as an example of the episodical way in which this book is written, utterly regardless of sequence, form, or coherence.

Another flagrant example occurs in Chapter VIII, where some half dozen important physical conditions are discussed one after the other, and each one dismissed after most imperfect treatment, because the author has allowed some chance idea to lead him off at a tangent.

The remaining chapters deal with the various well-known industrial applications of electro-chemistry, including primary and secondary batteries, and this half, although incomplete even so far as it goes, is yet the most satisfactory portion of the book; want of space prevents us from criticising it all in detail.

We need not discuss here the mere literary style of Prof. Hopkins's book—the far too frequent use of the word "beautiful," and other qualifying expresssions, the bad paragraphing, which appears, sometimes, to have been left to the discretion of the compositor—for, perhaps, tastes differ on these points, but we certainly think that such harmfully inexact and loose phrases as "ozone consists of three atoms of oxygen" (p. 139), that about latent heat quoted above, and numerous others scattered throughout the book, should be severely revised in future editions. An engineering student fed on slovenly writing is bound in time to develop loose thinking and slovenly working, and it is for this reason, if for no other, that we have thought it desirable to point out so prominently the blemishes which detract very seriously from the value of a readable and well got-up volume, which otherwise can be recommended as a useful addition to the very small number of English works on applied electro-chemistry at present available for the use of the student and worker.

Perhaps, after all, the faults are more than atoned for by the descriptions that are given of the experiments which illustrate the text, many of which are really strikingly brilliant from an educational point of view. But is there, we wonder, a college laboratory in England that can in any way compare with the splendid equipment of apparatus at the disposal of those fortunate enough to work in the chemical department of the George Washington University?

Wireless Telegraphy and Telephony. By D. Mazzotto. Translated by S. R. Bottone. London: Whittaker and Co. 1906. Price 6s. net.

This is a very comprehensive work in which apparently an attempt has been made to collect together information in a small space on everything which has been published on wireless telegraphy. Both good and bad information is included, up-to-date and out-of-date apparatus and systems. The work is, on the whole, well put together, but exhibits no originality or novelty, and is typical of the numerous essays of a semi-popular nature which have recently been produced, and which may be said to be interesting to man

but valuable to none. The author draws largely upon the published works and papers of others for his diagrams and illustrations, and adopts their methods of explaining the theory of the propagation of waves, but without any acknowledgment. Imitation, however, is flattery, and, therefore, acknowledgment is, perhaps, deemed superfluous.

FORTHCOMING EVENTS.

Saturday, September 8th.—At 7.30 p.m. Birmingham and District Electric Club. Opening meeting of the session. Election of members, &c.

September 12th, 13th and 14th.—Institution of Mining Engineers. Annual general meeting at Grand Hotel, Hanley, at 11 a.m. (12th). Papers for discussion:—"Commercial Possibilities of Electric Winding for Main Shafts and Auxiliary Work," by Mr. W. C. Mountain; "Electrically-driven Air Compressors combined with the working of Ingersoll-Sergeant Heading Machines," by Mr. A. Thompson; "Practical Problems of Machine Mining," by Mr. S. Mavor. At 4.15 p.m.—Visit to Messrs. Cowlishaw, Walker & Co.'s works. Compressed air and electrically-driven bar coal-cutting machines will be shown in operation. Thursday (14th).—Visit to the Sneyd Collieries at Burslem to inspect multiphase electrical plant, &c.; also Florence Colliery, Longton, to view surface arrangements and plants, electrical machinery, &c. Various other visits to works, &c., are on the programme.

NOTES.

Thomson-Houston Athletic Club Sports.—One of the most successful sports meetings held this season in the Midlands was that promoted at Rugby on Saturday, 17th inst., by the employés of the British Thomson-Houston Co., Ltd. The day, though not all sunshine, was, nevertheless, fine, and the sports ground was well filled by a large crowd of spectators. The position which this meeting holds in Midland athletic circles, may be judged from the fact that many of the most prominent officials of the M.C.A.A.A. assisted, including Mr. H. A. Butler, president of the Association; and Dr. Badger, Mr. E. B. Holmes, and Mr. A. E. Machin, vice-presidents. In consideration of the record number of entries received, among which were entries from no fewer than 20 champions and ex-champions, there were hopes of some splendid performances being witnessed, and in this respect no one was disappointed. Thanks also to the energy and ability of a capable committee, arrangements in general were almost perfect, and the various events were run off strictly to time, notwithstanding the huge number of starters in some of the races. From the list of results of the various events, we note that. A Russell, the captain of the Thomson-Houston Harriers, has again won the One Mile Steeplechase Championship of the Midlands. We also note that out of nine open events, members of the Thomson-Houston A.C. have secured six places, viz., two firsts, three seconds, and one third. The prizes were presented after the sports by Mrs. Conover, wife of the managing engineer of the B.T.-H. Co., Ltd.

Electric Motors and Fire-Damp in Mines.—The increasing application of electricity in coal mines renders it of great importance to ascertain what kind of protection against fire damp is possible and appropriate in regard to electric motors used in the pits. Experiments in this direction were made in 1903 by the Westphalian Mine Corporation Fund at the testing department established at the Consolidation Colliery, and these resulted in the obtaining by the firms interested of a basis for the construction of motors and apparatus secure from the dangers of fire damp. The Siemens-Schuckert Works Co. and the General Electricity Co. then each made a motor of from 25 H.P. to 30 H.P., having the form of protection suggested by the experiments. These motors have been subjected to all possible tests in the presence of fire damp, in the experimental department, and under all possible conditions, and also to trials in the presence of coal dust capable of being easily fired. A report prepared by the managers of the Mine Corporation Fund states that the form of protection which was chosen has completely answered the purpose in view, and it has therefore been possible to bring the tests provisionally to a close.

Contact Resistance of Carbon and Carbon-Metal Brushes.—Prof. Arnold, who was amongst the first investigators of the carbon brush resistance problem, has recently carried out further experiments on the subject, and a *résumé* of these is given in a recent number of *Der Elektrotechniker*. In order to avoid mechanical disturbance, slip rings were used in place of commutators. The contact resistances were measured by means of an ammeter and a delicate high resistance voltmeter. In some experiments the current was led in and out at two brushes rubbing on the same slip ring, but in others the positive and negative brushes were on separate rings, and differences in contact resistance were noticed in the two cases. Puzzling variations occurred in some of the first readings, but these were traced to vibration of the brushes and of the machine. Oscillographic records of the voltage drop at the brush contact showed that by varying the natural period of the brush (by sliding in or out) an adjustable weight fixed to the brush holder a species of resonance could be set up accompanied by considerable sparking. This trouble was avoided by inserting pieces of rubber under the springs of the brush holders. Amongst the brushes tested were the following:—

1. *Endruweit* Copper Carbon Brush.—In this brush the carbon is interleaved with numerous thin sheets of pure copper which increase the conductivity longitudinally to about five times its value laterally. The voltage drop at the contact at normal current densities is comparatively low—being about ·6 volt for the + and − brushes together. The slip ring, which was run at about 1,050 ft. per minute, showed a light brown colouring after an extended test. The voltage drop when the current flowed from ring to brush was greater than with the reversed direction of flow.

2. *Endruweit* Metal Brush.—This consists of electrolytically deposited metal leaves separated by a carbonaceous material intended to reduce the wear of the commutator. At a constant pressure of about 3 lb. per sq. in., the combined voltage drop at the + and − brushes amounted to about ·5 volt. In this case the drop was greater when the current flowed from brush to ring than for the reversed direction.

3. *Ringsdorf*. Type R III.—By the introduction of copper or brass strips in these brushes, the conductivity longitudinally is made about 12 times as great as that laterally. The combined voltage drop does not exceed ·4 volt. The drop is greatest when the current flows from brush to ring.

4. *Morganite* Brush. Grade I.—This is a very soft brush intended for a current density not exceeding 50 amperes per sq. in. The combined (+ and −) voltage drop was 1 volt. Grade II of the same make is suitable for 100 amperes per sq. in., and the maximum combined voltage drop was 1·13 volts. Both grades give the slip ring a deep carbon coating.

5. *Bronze-carbon*, made by the "Svenska Dynamoborstfabriken," of Stockholm. These consist of a mixture of carbon and bronze. Voltage drop, ·4 volt.

6. Le Carbone Carbon Brushes, Grade X.—With these the drop reaches a maximum of ·9 volt, and is greatest for the direction brush to ring. In all these tests reliable results could only be obtained after a long continued run, and it would seem that the temperature and humidity of the atmosphere affect the result considerably. The experiments are to be continued with a view to determining the electro-chemical and physical alterations which take place under the brush.

A Belgian Electrical Institution.—The United States Consul at Brussels, in a recent report, states that in October next there will be placed at the disposal of Belgians the Laboratory Museum of Electricity, of Brussels. This establishment was built and equipped and will be offered to the public by Robert Goldschmidt, of Brussels. The object of this philanthropic work is the development and extension of the use and application of electricity in Belgium by practical experimental instruction. The institution will contain all kinds of electrical models and appliances, which may be freely handled for study and experiment. Models and apparatus will be conveniently placed at the disposal of the public upon separate tables, and may be connected with the electric supply at will. For example, reduced models of every part of an electric tramway system, various dynamos, &c., are to be found in the museum. Mr. Goldschmidt hopes to extend the knowledge of the great possibilities of electricity by means of these practical methods. The institution is divided into four large rooms. The first is devoted to machines serving to produce phenomena due to magnetism, and to electricity and chemical reaction. This room will also be devoted to the demonstration of electrical laws. A circular gallery round the room is designated as the second hall; here are found machines of all sorts, lamps, bells, agricultural and dairy implements, conveniently exhibited, which may be worked by simply adjusting the electric appliances supplied to each table. There will also be free telegraph, wireless telegraph and telephone offices. The third hall is sub-divided into reading rooms, where the latest scientific publications will be on file. In the fourth hall will be found all kinds of large motors, dynamos, &c., with which the public are at liberty to study and experiment. There is no doubt that this institution, which has been planned and arranged with great forethought, will be of great benefit in affording free and practical instruction in the varied problems of electricity.

Electrical Production of Steel.—A party of the members of the American Institute of Mining Engineers, on the occasion of their recent visit to Germany, paid a visit to the works of the Elektrostahl Gesellschaft, at Remscheid, for the purpose of inspecting the plant installed for the electrical production of steel. This company, in which are interested the steelworks of Messrs. R. Lindenberg & Sons, the Berlin Handels Gesellschaft and the Deutsche Bank, is claimed to possess the first installation on a large scale. Since last March the steelworks already mentioned have exclusively worked up steel ingots produced by means of the electric smelting process based upon the Héroult patents, the exact method in use being said to be a combination of the open-hearth and electric furnaces. Only special qualities of steel and alloys of steel are manufactured by the plant in question, which is asserted to effect a reduction of 50 per cent. in the cost of production as compared with other existing systems. The visitors were received by Herr Lindenberg and Prof. Eichhoff, and were conducted through the works by them, in conjunction with Dr. Héroult and Dr. Rathenau, of Berlin.

The General Electric Sports.—On the 25th inst., in rather unsettled weather, the company's tenth annual sports were held at Belle Vue, Manchester, before a very large attendance. One of the new features introduced on this occasion was a fire brigade competition, also a 60 yards flat handicap confined to employés with ten years' service, for which a large number com-

peted. The prizes were both numerous and valuable, and amongst them it could be seen that the lady competitors had not been forgotten. During the sports the Salford Police Band discoursed charming music, and with an occasional outburst of sunshine the function was one of keen enjoyment. Mrs. Bevis, who had come up from London, distributed the prizes, and congratulated each of the winners. These sports are confined to the G.E.C. employés, who are able, by giving a good programme, to command large entries as well as a numerous following.

The "Annalen der Physik."—As a contemporary account and record of philosophical research in physics, the *Annalen der Physik*, under the editorship of such *savants* as Gren, Jilbert, Poggendorff, Wiedemann, and Drude has maintained throughout its history an honourable place in the scientific literature of the world; and nowhere has it been more appreciated than in this country. The untimely death of Paul Drude, on July 5th of this year, at the age of 43, casts a shadow across its pages. The character of the matter with which the periodical is concerned, the restriction to the hard facts of philosophy, and the suddenness of the loss, render the short obituary notice by Max Planck of the life of Paul Drude, as given in No. 9, Band 20, Heft 4, particularly impressive, enhanced as it is by the portrait of the man. Drude had edited the *Annalen* since 1899, and it will be universally admitted that during this significant period he carried out his task with success and with distinction.

By looking through the volumes published within the last 12 months it is possible to obtain some idea of the general direction that work in physics in Germany is taking. Overburdened though the contributions are with history and with words, there is probably no better way of forming an opinion as to the lines of progress than by glancing over these pages. In Germany, as in this country, there is evidence that physicists are giving too much time to publicity and too little time to research, and we are struck with the comparative dearth of accounts of experiments that could be fitly described as original. Reference may, however, be made to a paper by Jensen and Sieveking (No. 14, p. 695-724, 1905) on the use of microphone contacts for telegraph relays and for detecting weak currents. It is a review of a well-known set of phenomena, but it may be useful to those who are working in this field of research. In No. 2 (pp. 249-288, 1906) there is an extended account of a determination of the electro-chemical equivalent of silver, by G. van Dijk, who obtains the figure 0·011180, which is compared with similar determinations by other experimenters. A contribution which seems to break new ground is that of W. Frenkle (No. 4, pp. 692-714, 1906) who studies the magnetic properties of iron filings and reduced iron, when mixed with various proportions of non-magnetic substances. Another good piece of work is the investigation by F. Fischer (No. 8, pp. 503-526, 1906) of the change of resistance of palladium in proportion to the amount of hydrogen occluded. He shows that palladium when saturated occludes about 1,000 parts by volume of hydrogen, and he traces the resistance changes as the process goes on, the maximum resistance being about 1·69 times the normal resistance. The equation of change is given corresponding to occlusions from about 30 to 950 parts by volume of hydrogen, and corresponding coefficients are calculated to represent the changes that take place simultaneously in the dimensions (length) of the palladium wire. A simple experiment for the display of lines of discharge of electricity between electrodes is described by W. Holtz in the same volume (pp. 591-2). Gold leaf is broken up in 95 per cent. of alcohol until it is reduced to dust; the mixture is then poured over a glass plate and allowed to dry. It is said that 70 volts is sufficient to exhibit the lines. In No. 9 (pp. 677-722, 1906) there is an important paper by Erich Marx on the determination of the velocity of Röntgen rays. He confirms that the velocity is the same as that of light, and he describes apparatus which he considers is applicable generally to the measurement of rays having their origin in periodic movement.

Cost of Carbide of Calcium.—Taking the cost of electrical energy at £2 per kilowatt-year, and estimating the output of carbide obtainable by its agency at 2·1 metric tons, M. Ph.-A. Guye, of Geneva, estimates the cost of production of calcium carbide as follows:—

	Shillings per ton.
Lime, 1 ton	12
Coke, 700 kg.	14
Electrical energy, 0·47 KW.-year	19
Electrodes, 20 kg.	5·6
Wages	30·5
General expenses	17·6
Depreciation at 6 per cent. } Interest at 5 per cent. }	8·6
Total	107·3

This shows a marked advance on 1896, when the cost was nearly £16 per ton.—*L'Industrie Electrique.*

Educational Notes.—BATTERSEA POLYTECHNIC.—Evening classes in all electrical and mechanical engineering subjects begin on Monday, September 24th next.

HACKNEY TECHNICAL INSTITUTE.—The evening classes commence on September 24th next. Prospectuses can be obtained from the secretary.

For further particulars relating to these Institutes see our advertisement pages to-day.

EAST LONDON COLLEGE.—We have received a copy of the East London College calendar for the Session 1906-7, and notice that the Arts course for the London B.A. degree has been much extended, and very full courses (day and evening), under recognised teachers are arranged for the B.A., B.Sc., and B.Sc. (Engineering) degrees. The staff has been strengthened by the addition of Mr. G. S. Le Beau (Oxford Junior and Senior Mathematical Scholar), and by the appointment of Dr. C. H. Lees, F.R.S., as Professor of Physics. The engineering department of the College has been enlarged at the expense of the Drapers' Company, who have made a further grant of £5,000 for this purpose.

Lightning Effects on Underground Mains.—The following letter came to hand too late for insertion in our "Correspondence" columns, from Mr. Arthur H. Shaw, chief electrical engineer to the Ilford Urban District Council:—

"The following occurrence, being very unusual, if not unprecedented, may be of interest to some of your readers.

"During the morning of Friday, the 17th inst., a heavy thunderstorm passed over Ilford, and two houses adjoining each other were struck by lightning. Both the houses were wired for electric light, and the lightning in addition to going to earth through the water pipes, and fusing the taps, &c., struck the electric light fittings, fusing and tearing down the fittings.

"At the same time a serious fault developed on the mains, and it was found later that the insulation of the mains in the neighbourhood of the houses in question had failed in several places, certain house service boxes being burnt out, and a considerable length of distributor being entirely destroyed. At the same time the insulation of the mains at a point some 1,200 yds. distant from the houses failed, and fittings in a shop 900 yds. distant, and at a station 1,000 yds. distant from the houses, were fused and cut down. None of these fittings were switched on at the time, and the main fuses were only destroyed in one case.

"The system of mains is three-wire with neutral earthed at the station, the cables being lead-covered and laid solid.

"As this is the first time I have heard of an underground system of mains being interfered with by lightning, I should be glad to know if any of your readers have experienced a similar occurrence."

The circumstances appear to be unique. It would be interesting to know whether any effects were observed on the neutral wire at the generating station, whether the mains near the houses in question were concentric, and, if not, which were the mains that were damaged.

The Calculation of Starting Apparatus for Single-Phase Induction Motors.—This article, which was published in our last issue, was written by Mr. N. Pensabene-Perez, whose name was omitted through a misapprehension of his wishes.

British Motor-Boat Club.—The British Motor-Boat Club's three-day regatta will be held at Burnham-on-Crouch on September 13th, 14th and 15th. The programme is as follows:—On September 13th the "A. J. Wilson Perpetual Challenge Trophy" will be raced for by the fast-racing boats. The A. J. Wilson challenge cups for boats exceeding 25 and not exceeding 35 ft. overall, and for boats not exceeding 25 ft. overall, will also be raced for, as well as a race for cruisers for a cup presented by Mr. Oswald B. Colls. On the 14th, the race for the "*Motoring Illustrated* Challenge Cup," for boats exceeding 250 rating, will be held, and two other races, and on the 15th the Flying Mile will be held, two handicaps preceding this. Entries for these races will close at noon on September 6th.

An Electro-Magnetic Cannon.—A correspondent writes that Prof. Christani Birkeland has worked out some interesting figures in regard to an electro-magnetic cannon, from which we learn that a projectile weighing 2 tons would be given an initial velocity of 300 metres per second when placed in a tube 27 metres in length and propelled by an electro-magnetic force generated by 1,620,000 KW., the projectile acting as the core of a solenoid. At the present time there are few stations having machinery of more than 30,000 KW., so that there will be some difficulty in practically experimenting with the theory set forth.

Spanish Electrical Tariffs.—The United States Consul at Barcelona in a recent report states that the new Spanish tariff will have the effect of almost shutting out of Spain foreign electrical machinery and apparatus, the duty being raised to 1 peseta (9½d.) per kilogramme. This will affect Germany, France, Switzerland, England and the United States. The electrical industry has been steadily growing in Spain, particularly in Barcelona, during recent years, and the new tariff is designed solely for the protection of home industries.

Institution Notes.—TRAMWAYS AND LIGHT RAILWAYS ASSOCIATION.—The Official Circular of the Association for August contains an up-to-date list of the 418 members, past and present, together with the memorandum and articles of association, and a copy of the B. of T. licence to omit the word "limited" from the title. We note that 184 members joined in 1900, when the Association came into being, 50 in 1901, 71 in 1902, 25 in 1903, 32 in 1904, and 32 in 1905. Deliberations on the subject of the suggested amalgamation of the three tramway associations will take place during the meeting of the Municipal Tramways Association on September 19th, 20th and 21st next, at Leeds.

Appointment Vacant.—An electrician-in-charge is required for Shoreditch at 38s. per week. See our advertisement pages to-day.

The Italian Electro-technical Association.—The general meeting of this society will be held on September 30th at Milan; a programme is being arranged to visit numerous factories in the neighbourhood and the hydro-electrical installations which have been recently constructed.

The *Journal* of the Association for January to April, 1906, contains communications on the circle diagram of polyphase machines employed as motors and as generators; the results of micro-telephonic transformations; considerations as to the application of electric traction on the lines of Valico, by Engineer Lanino; on the present position of wireless telegraphy; and on mercury vapour lamps. Amongst the records of the proceedings is a note that the Association has elected Lord Kelvin an honorary foreign member, and his name appears in this capacity on the first page of the *Journal*.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the* ELECTRICAL REVIEW *posted as to their movements.

Central Station Engineers.—Mr. LAWRENCE BIRKS, managing engineer to the Electric Construction Co. at Christchurch, has been selected out of 51 applicants to fill the post of Government engineer-in-charge at Rotorua, N.Z., at a salary of £800 per annum, in succession to Mr. R. C. White, who died not long ago.

On Friday last Mr. J. A. BROMLEY, sub-station attendant with the Wakefield and District Light Railway Co., was presented by the engineering staff with a massive silver matchbox on his leaving to take up a similar position with the Leeds Corporation.

Mr. J. J. CUNLIFFE was presented with a fumed oak timepiece by the staff and workmen of the Partick Electricity Department, on 27th inst., on his leaving to fill the post of engineer-in-charge at Preston.

On Monday last Mr. B. SANKEY, chief assistant at Mansfield Corporation Electricity Works, who has been appointed borough electrical engineer at Whitehaven, was the recipient of a smoking cabinet from the members of the staff, and a gold-mounted umbrella, suitably engraved, from the other works employés. Mrs. Sankey was also presented with a volume of "Tennyson," by the staff. Mr. Sankey takes up his official duties at Whitehaven on September 3rd.

General.—At a recent meeting of the Electrical Association of Victoria (Australia), Mr. W. SYKES was appointed secretary in place of Mr. Clement Newton, resigned.

The Brighton staff of the National Telephone Co. have presented a brass curb and fittings, a Gladstone bag and a chair to Mr. FREDERICK JAMES FROST, traffic manager, on his marriage to Miss May Ratcliffe Young, of Hove.

Mr. H. J. MACLURE, contract manager at Brighton for the National Telephone Co., who is leaving to take up a similar position at Birmingham, was, on August 22nd, presented by the Brighton staff with a case of silver fish knives and forks and spoons.

In our last issue we stated that Mr. T. H. SAUL had received an appointment at Fulham; this was an error, the appointment being with the Urban District Council of Acton, to which Mr. J. Martin Blair is the electrical engineer.

Owing to pressure of private business, Mr. C. S. NORTHCOTE, M.I.E.E., director of Veritys, Ltd., has taken an office at No. 22, Queen Anne's Chambers, Broadway, Westminster (telephone No. 807 Westminster), where he will be pleased to receive correspondence from members of the electrical profession.

NEW COMPANIES REGISTERED.

East Africa and Uganda Corporation, Ltd. (89,933).—This company was registered on August 22nd, with a capital of £100,175 in 100,000 shares of £1 each and 3,500 shares of 1s. each, to promote and conduct companies for carrying on in Uganda, British East Africa and elsewhere, banks, railways, canals, docks, waterworks, gasworks, telegraphs, telephones, electric light and power works, mining operations and financial, industrial and exploration undertakings, to acquire and turn to account land in Uganda or elsewhere, and to acquire upon the terms of an agreement with the East African Exploitation Syndicate the benefit of the negotiations carried on by the said syndicate for the formation of a bank, the construction of certain railways, the production and distribution of electric power, the exploitation of forests and cultivation of rubber, cotton and fibre bark, and the establishment of hotels, stores, trading stations, stock and other farms, creameries, bacon-curing and cold storage factories, &c. The first subscribers (each with one share) are:—Sir Frederick W. R. Fryer, 23, Elvaston Place, S.W., Indian Civil Service (retired); W. P. J. Fawcus, 2, Queen Anne's Place, S.W., civil engineer; R. P. Sellon, 4, Queen Victoria Street, E.C., electrical engineer; R. C. Abdy, Alexandria, merchant; C. S. Cox, 27, Leadenhall Street, E.C., merchant; E. Gedge, The Grange, Upper Halliford, Middlesex, director; Sir Ernest Cable, 27, Leadenhall Street, E.C., merchant; Lord Hindlip, Hindlip Hall, Worcester. No initial public issue. The number of directors is not to be less than two or more than ten; the first are R. C. Abdy, Sir Ernest Cable, C. S. Cox, Sir Frederick W. R. Fryer, R. P. Sellon, W. P. J. Fawcus, E. Gedge and Lord Hindlip; qualification (except first directors, who require none), £500; remuneration, £150 each per annum (chairman £250 extra) and 10 per cent. of the profits available for distribution after 6 per cent. dividend has been paid on the ordinary shares.

Britannia Mills (Long Eaton), Ltd. (89,909).—This company was registered on August 20th, with a capital of £35,000 in £10 shares, to acquire land for the erection of a lace factory, to sublet the same to lace manufacturers or others, to provide power, light and heat for use of tenants, to adopt an agreement with Drake & Gorham, Ltd., and to carry on the business of manufacturers of and dealers in lace curtains and nets, manufacturers, finishers and dressers of, agents for and dealers in lace, bleachers, dyers, yarn merchants, silk manufacturers, &c. The first subscribers (each with one share) are:—S. A. Wallis, West Villa, Long Eaton, lace manufacturer; Mrs. M. A. Wallis, West Villa, Long Eaton; E. Wallis, Inglehurst, Long Eaton, lace manufacturer; Mrs. E. M. Wallis, Inglehurst, Long Eaton; F. W. K. Wallis, Trent Lea, Long Eaton, lace manufacturer; Mrs. A. L. Wallis, Trent Lea, Long Eaton, lace manufacturer; and W. Smith, 25, Alexandra Road, Southport, cotton manufacturer. No initial public issue. The number of directors is not to be less than two or more than five; the first are E. Wallis, F. W. K. Wallis, S. A. Wallis (chairman), and W. Smith ("original directors"); qualification, £100; remuneration as fixed by the company. Registered office, Britannia Mills, Bennett Street, Long Eaton, Derby.

Westinghouse Metal Filament Lamp Co., Ltd. (89,948).—This company was registered on August 23rd, with a capital of £10,000 in £1 shares, to adopt an agreement between Felix Kuschenitz of the first part, G. Westinghouse of the second part, and this company of the third part, and to carry on the business of manufacturers of and dealers in electric lamps and other apparatus, electricians, engineers, makers and suppliers of and dealers in electricity, electric power and light, &c. The first subscribers (each with one share) are:—N. Carlton, 2, Norfolk Street, Strand, W.C., engineer; A. E. Scanes, 2, Norfolk Street, Strand, W.C., director; J. H. Lukach, 2, Norfolk Street, Strand, W.C., director; R. Belfield, 2, Norfolk Street, Strand, W.C., engineer; A. S. Cachemaile, 2, Norfolk Street, Strand, W.C., clerk; L. W. Jenkins, 2, Norfolk Street, Strand, W.C., secretary; and another. No initial public issue; the number of directors is not to be less than two or more than seven; the first are G. Westinghouse, J. H. Lukach, G. Leve, Felix Kuschenitz and R. Belfield; remuneration as fixed by the company. Registered office, Westinghouse Building, Norfolk Street, Strand, W.C.

Westinghouse-Cooper, Hewitt Co., Ltd. (89,947).—This company was registered on August 23rd, with a capital of £10,000 in £1 shares, to enter into any arrangement or contracts or take any licences for the Cooper, Hewitt Electric Co., of New York, in particular with regard to the Cooper, Hewitt, mercury vapour lamp and other apparatus, and to carry on the business of electricians, engineers, makers and suppliers of electricity, electric power and light, &c. The first subscribers (each with one share) are:—N. Carlton, 2, Norfolk Street, Strand, W.C., engineer; A. E. Scanes, 2, Norfolk Strand, W.C., director; J. H. Lukach, 2, Norfolk Street, Strand, W.C., director; R. Belfield, 2, Norfolk Street, Strand, W.C., engineer; A. S. Cachemaile, 2, Norfolk Street, Strand, W.C., clerk; L. W. Jenkins, 2, Norfolk Street, Strand, W.C., secretary; and another. No initial public issue. The number of directors is not to be less than two or more than ten; the first are G. Westinghouse, N. Carlton, F. E. Drake, F. Hessenberg, R. Belfield, J. H. Lukach, A. E. Scanes, and Max von Recklinghausen; remuneration as fixed by the company. Registered office, Westinghouse Building, Norfolk Street, Strand, W.C.

R. G. E. Syndicate, Ltd. (89,925).—This company was registered on August 21st, with a capital of £20,000 in £100 shares, to seek and secure openings for the employment of capital in South America or elsewhere, and to own, work, control and turn to account tramways, railways, bridges, harbours, reservoirs, watercourses, waterworks, hydraulic works, wharves, &c. The first subscribers (each with one share) are:—I. A. J. Smith, 69, Broadfield Road, Catford, clerk; C. Dassett, 9, Duncombe Hill, Forest Hill, S.E., clerk; A. W. Podger, 1, Forest View Road, Whipp's Cross, Leyton, clerk; C. C. Rawlinson, 1, Priory Gardens, Priory Road, Hornsey, clerk; A. T. Escott, 24, Durlston Road, Clapton, cashier; C. E. Ingall, Killarney, Sevenoaks, clerk; and F. Hopton, 16, Delamere Terrace, Paddington, W., clerk. No initial public issue. The number of directors is not to be less than two or more than six; the subscribers are to appoint the first; remuneration as fixed by the company.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Uxbridge and District Electric Supply Co., Ltd. (62,706).—Issue on August 20th of £1,600 6 per cent. debentures, part of series created July 10th, 1906, to secure £15,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £7,800.

Art Fittings, Ltd., London (73,907).—A debenture dated August 14th, 1906, to secure not more than £1,000, charged on the company's undertaking and property, present and future, including uncalled capital, has been registered. Holders: Drake & Gorham, Ltd., 66, Victoria Street, Westminster.

Northampton Electric Light and Power Co., Ltd. (28,640).—Issue on August 17th of £150 4 per cent. debentures, part of series created June 3rd, 1906, to secure not more than two-thirds of the subscribed paid-up capital, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees. Previously issued of same series, £35,600.

Chadburn's (Ship) Telegraph Co., Ltd. (56,574).—This company's annual return was filed on July 10th, when the entire capital of £120,000 in 60,000 preference and 60,000 ordinary shares of £1 each had been taken up. £1 per share has been called up on 50,000 preference and 50,000 ordinary, and £100,000 has been received. £20,000 is considered as paid on 10,000 preference and 10,000 ordinary. Mortgages and charges: nil.

New General Traction Co., Ltd. (47,321).—This company's annual return was filed on July 20th, when the entire capital of £370,000 in 50,000 preference and 24,000 ordinary shares of £5 each had been taken up. £5 per share has been called up on the preference, and £250,000 has been received. £120,000 is considered as paid on the ordinary. Mortgages and charges: £280,000.

Electric and General Investment Co., Ltd. (31,506).—This company's annual return was filed on July 25th, when the entire capital of £200,000 in 20,000 ordinary, 100 founders' and 19,900 preference shares of £5 each had been taken up. £1 per share has been called up on the ordinary and £5 per share on the founders' and preference, and £120,000 has been received. Mortgages and charges: nil.

A. Hirst and Son, Ltd. (57,889).—This company's annual return was filed on July 13th, when 100 preference and 310 ordinary shares had been taken up out of a nominal capital of £5,000 in 100 preference and 400 ordinary shares of £10 each. £10 per share has been called up on 100 preference and 10 ordinary and £1,100 has been received. 300 ordinary shares are considered as fully paid. Mortgages and charges: £2,000.

Bastian and Partners, Ltd. (electricity meter manufacturers, London) (77,601).—Issue on July 31st of £75 10 per cent. debentures, part of series created July 1st, 1905, to secure £4,000, charged on the company's undertaking and property, present and future. No trustees. Previously issued of same series: £2,700.

CITY NOTES.

Southport and Lytham Tramroad Co.

The half-yearly general meeting of the shareholders was held at the company's offices in Liverpool last week. The directors reported that purchases had been effected, or agreements entered into, for the acquisition of land required on the south side of the Ribble, and on the north side negotiations for the greater portion of the land required had been completed. The Bill for extending the time for the completion of the company's undertaking had received the Royal Assent. None of the capital authorised under the company's last two Acts had yet been created or sanctioned, and there remained a total balance of £321,200 to be created or sanctioned, out of a total capital authorised of £373,330. The receipts by shares up to December 31st were £38,882 18s. 6d., to which was added £782 1s. 6d., the amount received during the past half-year, making a total of £39,665 on account of shares. During the past half-year, £2,000 was also received by way of loans, bringing the total receipts to date up to £41,665. After the expenditure up to June 30th last had been met, there was a balance of £500 10s. 7d. Of the capital expenditure during the last half-year, £2,010 6s. 6d. went in money for the purchase of land. During the current half-year it is estimated that £5,000 will be further expended on capital account for land and works, leaving £327,165 10s. 7d. to be expended during subsequent half years. Mr. J. Merrett Wade has been elected a member of the board to fill the vacancy caused by the death of Mr. H. A. Watson.

Mersey Railway Co.

The report of this company for the half-year ended June 30th, states that the train mileage run during the half-year was 412,633, as compared with 412,215 during the corresponding six months of 1905. The number of passengers conveyed during the half-year was 5,352,867, as against 4,862,378 for the corresponding period of 1905, exclusive of season ticket holders. The total receipts from all sources for the half-year amounted to £47,129, as compared with £43,356 for the corresponding period of 1905. Working expenses, exclusive of the charges for pumping, ventilation and lifts, have been £31,119, equal to 66·03 per cent., as against £30,779, equal to 70·70 per cent. for the corresponding six months. These charges for pumping, ventilation and hydraulic lifts for the past half-year amounted to £3,926, equal to 8·33 per cent., as compared with £3,948, or at the rate of 9·07 per cent. for the corresponding period of 1905. The Mersey Railway Act, 1906, received the Royal Assent on June 22nd, 1906, and under it the period of five years fixed by the Mersey Railway Act, 1900, with reference to the interest on debenture stocks and the representation of the debenture stockholders on the board, has been extended for a further period of five years from December 31st, 1905. The powers relating to the running of motor-omnibuses which were asked for in the Bill were passed by the House of Lords, but were rejected by the House of Commons on the opposition of the Corporation of Birkenhead. In conformity with the provisions of the Act, meetings of the holders of the debenture stocks, 1866, 1871, 1882-3-5 and "B" respectively, were held on July 27th last, when the debenture stockholders appointed the following directors to represent their interests on the board:—4 per cent. debenture stock (1866), Mr. Henry Allan Wakeman-Newport; 3 per cent. debenture stock (1871), Mr. Robert Cooper; 3 per cent. debenture stock (1882-3-5), Mr. Samuel Gurney Sheppard; 3 per cent. "B" debenture stock, Mr. George Waddell. Mr. Cooper and Mr. Wakeman-Newport having retired from office as representatives of the shareholders, the board have elected the Hon. Richard Clere Parsons and Mr. Samuel Gurney Sheppard to fill up the vacancies. We gather that the balance to net revenue account amounted to £12,083, as compared with £8,809 in the corresponding period of 1905; to the former amount is added £4,736, interest payable by the British Westinghouse Co., and other small amounts. Interest on debenture stock, extensions, rent, &c., absorb £16,921, leaving a debit balance of £10. The total debit balance is £8,451.

Tyneside Tramways and Tramroads Co.

The half-yearly meeting of the company was held on the 28th inst. at Newcastle-upon-Tyne, Lord Armstrong, chairman of the company, presiding.

The Chairman, in moving the adoption of the annual report, said it indicated that very considerable progress had been made by the company towards recovering the loss of traffic sustained through the electrification of the North-Eastern Railway to Tynemouth. As a matter of fact, the receipts exceeded the expenses by a greater amount than during any previous half-year. They had been able to recommend a dividend of 1½ per cent., to place £900 to the credit of the depreciation and contingency fund, and as the first half year was always the better half, to carry forward £607. As the capital account was now practically stationary, and as no further capital expenditure was in contemplation, they had reasonable grounds for anticipating that the dividend would shortly become more satisfactory, provided that the present rate of progress was maintained. Their expenses per car-mile had gone down slightly, being for the last half year 5·55d. In considering the question of depreciation, he reminded them that the percentage allowance for this was in their case affected by the fact that their tramways were only purchasable by local authorities at a fair market value as a going concern, and by the fact that considerable sums had been expended by them on land. In other words, they approached more nearly railway companies than did the average tramway company. They had, besides, carried out all repairs and renewals to railway stock and permanent way out of revenue; and as they purchased their electricity from outside sources, they had to make no allowance for the depreciation of a power station, which certainly tended to become antiquated more rapidly than did any other portion of a tramway system. There was a traffic receipt increase of £747, which was an all-round improvement. The Chairman pointed out that the agreement with the Newcastle Corporation provided for through traffic facilities over three routes, but up to the present these facilities had only been given in the case of two routes, namely, the main line to Wallsend, and the route to Gosforth Park. As the expenditure for securing the agreement was heavy, and as the results from the through traffic on the two routes had been satisfactory, they were naturally anxious to get the third route, that along the riverside from Wallsend to Newcastle, opened as speedily as possible. This latter section, it seemed, brought up grave engineering objections, so that, although they, on their side, had everything in complete readiness, two years had elapsed since the agreement was signed without the line being opened. He was glad, however, to be able to report that the Corporation were carrying out such alterations to their lines as would enable a through service to be given before the end of the year.

Dr. Merz, in seconding the adoption of the report, expressed the opinion that the business of the company was now slowly but surely rising.

The report was formally adopted.

W. T. Glover & Co., Ltd.—The company has issued £80,000 5 per cent. second mortgage debenture stock at 95 per cent., being part of an authorised issue of £100,000.

Stock Exchange Notices.—The Stock Exchange Committee has ordered the under-mentioned securities to be quoted in the Official List:—

New York Central and Hudson River Railroad Co.—$1,036,000 additional 3½ per cent. coupon gold bonds of 1997 for $1,000 each, Nos. 83,947 to 84,982.

Shawinigan Water and Power Co.—Further issue of $500,000 5 per cent. consolidated first mortgage bonds, Nos. 2,001 to 2,318 of $1,000 each, and 5,002 to 5,365 of $500 each.

Aberdeen Suburban Tramways Co., Ltd.—A dividend at the rate of 2½ per cent. for the six months ending July 31st is recommended; £131 will be carried forward. The same rate was adopted last year.

Davis & Timmins, Ltd.—A dividend at the rate of 6 per cent. is recommended on the preference shares, for the six months ended June 30th.

British Insulated and Helsby Cables Co., Ltd.—The directors have declared an interim dividend on the ordinary shares at the rate of 8 per cent. per annum for the half-year ended June 30th last.—*Financial Times.* The rate was the same last year.

Blackpool and Fleetwood Tramroad Co.—The half-yearly meeting was held on the 21st inst. The report shows receipts amounting to £11,204; passengers carried, 877,825. The profit balance, after providing debenture interest, was £4,111; it was recommended to pay a dividend of 4 per cent. (the same as last year), write off £500 for depreciation, &c., and place £560 to reserve, leaving a balance of £50 to be carried forward.

Continental.—Belgium.—The balance-sheet of La Société de la Fabrique Belge de Crayons Electriques, of Liége, for the last financial year, shows a loss of £1,900.

Italy.—La Societá Idro-Elettrica Ligure-Meridionale is the name of a new company which has lately been formed in Genoa, with a capital of £22,000.

The Lombardy Society for the Distribution of Energy.—Formal resolutions having been approved at the general meeting on May 30th last, the directors are proceeding to issue further shares increasing the capital of the company from 13 millions to 15 millions of lire (£520,000 to £600,000). The shares are of 500 lire each, and 3,250 of the new issue are reserved to existing shareholders.

The Edison Electrical Co. of Milan.—An extraordinary general meeting was recently held to consider an increase of the company's capital; 68 shareholders were present, representing 16,901 shares. The following extracts are taken from the statements put before the meeting by Engineer Esterle:—"The remarkable extensions which we are called on to provide for electric lighting, motive power and working of tramways in the city and in the province of Lombardy, necessitate our finding the necessary capital to carry out the works. We are also interested in the electrical undertakings of Como, Novara and Venice. For increasing the tramway service a sum of 4,000,000 liras is necessary, for the installation of a new unit at Porta Volta 2,800,000 liras, for the new station at Porta Vigentina with trunk mains and distributing suburban network 700,000 liras, for participation in other electrical undertakings 1½ millions liras; this makes a total of 9,000,000 liras, for which we already have authority to raise one-third, so that the amount under discussion to-day is 6,000,000 liras in round figures. It is proposed, therefore, to issue 10,000 new shares of the nominal value of 150 liras each at a price of 600 liras each, these to be offered to existing shareholders in the proportion of 1 to 10." After some brief observations by some of the shareholders, the proposals were unanimously adopted.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

Locality.	Fortnight ended.	Receipts for the fortnight. £	Receipts for the fortnight. £*	No. of wks.	Total to date. £	Total to date. £*	Route miles open.	*
Aberdeen	Aug. 22	3,242	— 20	12	18,892	— 293	14·4	..
Ayr	,, 25	900	— 17	15	6,236	— 37	8	..
Bath	,, 25	2,103	+ 465	34	27,760	+ 4,733	13	..
Belfast	,, 24	7,009	+2,747	34	110,812	+32,487	40	+ 6½
Birkenhead	,, 26	2,217	+ 69	21	22,992	+ 321	13·5	..
Blackburn	,, 22	2,103	— 46	21⅔	23,114	+ 1,313	13·6	..
Blackpool Corp.	,, 23	6,521	— 149	21	31,948	+ 1,703	11·37	..
,, —Fleetw'd	,, 25	4,539	+ 156	8	13,192	+ 1,283	8·25	..
† ,, —Lytham	,, 2	825	+ 155	39	12,897	+ 1,353	7½	..
Bolton	,, 26	4,651	+ 215	21	43,414	+ 2,896	26	+ 1
Bournemouth	,, 22	4,993	+ 760	20⅔	37,169	+ 7,603	18·75	+ 6½
Bradford	,, 25	9,558	— 67	21	99,746	+ 3,898	53	..
Brighton	,, 26	2,738	— 93	21	23,327	..	9·5	..
Bristol	,, 24	10,380	+ 126	..	..	..	28·5	..
Brit. Elec. Trac. Co								
Airdrie	Aug. 17	452	+ 11	33	7,216	+ 659	3·65	..
Barnsley	,, 17	375	— 7	,,	5,344	+ 40	..	..
Barrow	,, 17	773	+ 52	,,	8,426	+ 474	5·37	..
Cavehill	,, 17	243	+ 190	,,	2,944	+ 1,161	..	..
Devonport	,, 17	1,147	+ 12	,,	14,982	— 363	8·85	..
Gateshead	,, 17	2,061	+ 31	,,	31,785	+ 1,722	11·25	..
Gravesend, N'fleet	,, 17	704	+ 42	,,	7,941	+ 312	6·5	..
Greenock	,, 17	1,606	+ 112	,,	21,904	+ 905	7·25	..
Hartlepool	,, 17	818	+ 125	,,	9,860	+ 1,156	6·72	..
Kidderminster	,, 17	472	+ 23	,,	4,059	— 36	..	..
Leamington	,, 17	491	— 98	,,	5,895	+ 2,734	3	..
Merthyr	,, 17	472	+ 33	,,	6,442	+ 121	2·9	..
‡Metropolitan	,, 17	8,563	+ 655	,,	111,740	+26,931	22	..
Middleton	,, 17	843	+ 22	,,	11,652	+ 315	8·5	..
Mid. Joint Com'tee	,, 17	21,884	— 507	,,	336,303	+11,726	..	..
Oldham — Ashton	,, 17	1,279	— 33	,,	18,625	+ 497	9·13	..
Peterborough	,, 17	442	— 7	,,	4,299	— 329	5·31	..
Potteries	,, 17	3,718	+ 182	,,	58,362	+ 2,936	29	..
Rothesay	,, 17	1,442	+ 132	,,	7,970	+ 1,083	2·75	..
Southport	,, 17	1,064	+ 26	,,	10,627	+ 283	8·17	..
Swansea	,, 17	2,443	+ 206	,,	27,296	+ 4,716	5·5	..
Tynemouth	,, 17	1,012	+ 26	,,	8,719	— 180	3·75	..
Weston-s-Mare	,, 15	1,127	+ 92	,,	4,843	+ 214	3	..
‡Worcester	,, 17	841	— 39	,,	9,849	— 761	5·75	..
Wrexham	,, 17	279	+ 29	,,	3,366	+ 20	..	..
Yorks. Wool. Dist.	,, 17	1,996	+ 460	,,	29,681	+ 8,534	17	..
Miscellaneous	,, 17	352	— 43	,,	3,448	— 562	..	..
Burnley	,, 25	2,488	+ 147	33	..	..	7·5	..
Burton-on-Trent	,, 26	670	— 45	21	6,668	— 432	9·5	+ 1
Bury	,, 19	2,026	..	20	20,390	..	10·5	..
Cardiff	,, 18	5,073	+ 179	20	43,132	— 908	17·6	..
Carlisle	,, 25	420	— 28	34	6,299	— 79	..	..
Chatham and Dist.	,, 23	1,460	— 69	34	23,206	— 545	10·29	+ ·96
Colchester	Mar. 7	327	— 5	31	5,600	..	7½	+ ½
Cork	Aug. 23	1,108	+ 6	34	16,345	— 339	9·89	..
Croydon	,, 24	3,033	+ 116	12	19,865	+ 1,260	11·25	+ ·5
†Darlington	,, 18	216	+ 3	20	4,332	+ 134	4·67	..
Darwen	,, 24	485	+ 11	21	5,423	+ 183	4·36	..
Dover	,, 25	720	+ 71	21	5,994	+ 521	4·75	+ 1½
Dublin	,, 24	11,174	— 542	8	44,851	— 71	48·75	+ ·25
Dundee	,, 22	2,179	+ 414	14	15,804	+ 3,292	13	+ ·5
East Ham	,, 25	1,857	+ 81	21	20,178	+ 1,751	8	+ ½
Exeter	,, 24	701	+ 40	21	6,441	— 365	4·25	..
Glasgow	,, 25	33,776	+3,703	15	206,793	+16,064	81·75	+ 6
Halifax	,, 22	3,692	— 461	21	36,648	+ 1,089	37	+ 1·5
Hastings	,, 24	2,795	..	..	..	..	..	..
Huddersfield	,, 25	3,236	+ 91	21	32,880	+ 2,964	28	..
Hull	,, 25	4,567	+ 152	21	48,040	+ 951	13	..
Ilford	,, 25	991	— 60	21	10,964	+ 9	6·37	..
Ilkeston	,, 23	288	+ 52	21	2,891	+ 249	3·5	..
Ipswich	,, 25	1,099	— 28	21	9,973	— 233	10·5	..
Isle of Thanet	,, 25	3,812	— 103	34	22,887	— 468	11	..
Kilmarnock	,, 25	808	— 6	15	2,476	— 85	4·12	..
Kirkcaldy	,, 22	505	+ 28	..	..	..	7·5	..
Lan'kshire Trm. Co.	,, 23	1,887	— 27	34	29,509	+ 5,629	12·56	+ ½
Leeds	,, 18	13,646	+ 734	20	128,826	+ 6,394	96	+ 6½
Leicester	,, 25	4,303	+ 57	34	75,057	+ 4,532	..	..
Leith	,, 18	1,126	+ 507	13½	7,549	+ 3,967	6	+ 1
Liverpool	,, 18	23,252	+ 15	33	354,145	+ 5,432	104	+ 1
‡L.C.C.	,, 11	54,495	..	19	507,149	..	99	+47½
London United	,, 24	14,248	+ 729	34	212,711	+12,551	..	..
Lowestoft	,, 25	923	— 66	48	8,175	— 632	3·5	..
Manchester	,, 25	28,463	+2,016	21	292,005	+14,809	146	+21
Newcastle	,, 25	7,821	+ 458	21	86,903	+ 5,465	25·5	..
Newport	,, 18	1,532	+ 104	20	13,040	+ 554	14·5	+ 1·5
Northampton	,, 24	955	+ 5	21	9,882	+ 46	5·5	..
Oldham	,, 26	3,984	+ 340	22	40,428	+ 3,501	23·75	..
Pontypridd	,, 25	330	+ 24	21	3,635	+ 30	3·5	..
Portsmouth	,, 25	5,578	— 199	21	47,114	— 1,842	14·5	..
Preston	,, 22	1,743	+ 77	..	..	..	10	..
†Reading	,, 16	676	— 16	20	13,088	— 52	7·5	..
Rochdale	,, 25	2,362	+ 275	20	23,077	+ 6,592	20·6	+ 1½
Rotherham	,, 23	1,079	+ 128	21	10,643	+ 1,040	9·33	..
Salford	,, 20	3,935	+ 62	20	93,242	+ 1,201	38·9	..
Sheffield	,, 26	10,833	+1,019	22	117,350	+ 7,047	35·75	+ 1½
Southampton	,, 22	2,250	— 46	20	21,123	— 4	..	..
Southend-on-Sea	,, 22	1,498	+ 61	21	9,677	+ 269	6	..
†Stalyb'dge, Hyde, &c	Apr. 21	807	+ 100	3	2,456	..	21	..
Stockport	Aug. 17	2,295	+ 216	20	20,492	+ 5,722	15·5	+ 4
†Sunderland	,, 26	1,592	+ 140	21	31,118	+ 1,419	10·87	..
Swindon	July 3	331	— 83	13½	2,642	— 49	4·4	..
Tyneside	Aug. 22	925	+ 27	34	15,503	+ 1,084	8·87	..
Walthamstow	,, 25	1,336	..	21	14,000	..	10	..
West Ham	,, 23	4,453	+ 37	21	48,883	+13,294	14·7	+ 1·4
Wolverhampton	,, 22	1,732	..	..	..	..	10	..
Yorks. W. Riding	,, 26	1,749	+ 67	34	28,292	..	..	..
Baker St.-Waterloo	,, 25	2,488	..	8	10,427	..	3·25	..
Cen. London Rly.	,, 25	9,955	— 547	8	43,396	— 2,027	6	..
City & S. Lon. Rly.	,, 26	4,675	+ 134	8	19,330	+ 1,296	6·25	..
Dublin-Lucan Rly.	,, 24	300	— 2	8	1,171	— 39	7	..
G. N. and City Rly.	,, 25	2,973	+ 215	8	12,378	+ 987	3·5	..
L'pool Overh'd Rly.	,, 26	3,185	— 104	8	12,226	— 506	6·75	..
Mersey Railway	,, 25	3,261	+ 272	8	13,137	+ 1,096	4·5	..
Metropolitan Rly.	,, 26	26,991	..	8	115,390	..	70·5	..
Met. District Rly.	,, 26	12,918	+1,080	8	58,004	+ 6,751	24	..
Anglo-Argentine	,, 26	29,820	+4,035	34	502,705	+58,786	43	..
§Auckland	June 22	10,225	+1,319	25	61,419	+ 4,193	18·64	..
§Brisane	July	11,158	+ 896	..	..	..	..	..
§Brit. Columbia Rly.	,,	18,433	+2,807	4½	18,433	+ 2,807	..	..
Bu'n's A'r's E.T.Co.	,, 21	2,706	+ 429	29	39,715	+ 7,258	24	..
Bu'n's A'r's-Bgr'no	Aug. 19	7,986	+ 659	33	118,066	+ 6,752	..	..
Calcutta	,, 25	5,878	+ 190	..	..	..	..	..
§Cape Electric T. Ld.	May	14,806	..	..	..	..	..	..
§Geneva	July	8,188	..	..	..	..	..	..
§Kalgoorlie	,,	3,980	..	30	29,887	..	20·5	..
Madras	Aug. 15	948	+ 173	32	14,244	+ 1,318	..	..
Perth (W.A.)	,, 24	2,653	+ 125	34	49,973	+ 3,008	24·25	+ 5

* Compared with the corresponding period of 1905. † One week only.
‡ Includes horse, steam and other receipts. § One month.

STOCKS AND SHARES.

Tuesday Evening.

SPECULATION has completely ousted investment from the premier position which the latter should, at any rate theoretically, occupy in Stock Exchange business. Investment for several days was overhung by the lumpishness of Consols, and when the Funds began to improve in connection with the Money Market, there was a slightly better tone in the departments which cultivate investment. The Chilian disasters are reflected in the price of Chili Telephone shares, but the Cuban revolution has an influence as indirect as that wielded by the latest Russian news.

Home Railway stocks are amongst the dullest in the Stock Exchange. The steam lines are entirely out of favour, and the growing dissatisfaction of a large body of railwaymen with their hours of labour and their pay, is certainly imposing a check upon investment inquiry for the stocks. Electrical issues cannot go ahead in price if the other sections of the market are weak, and therefore the proprietor of the stocks derives little consolation from a perusal of this week's prices.

Attention has several times of late been directed to the better tone in Electricity Supply shares. Prices had been slow to advance, but at length there are several rises to record. Judicious advertisement of the charms of City of London shares and County of London shares is having its due reward in the improvement of the values. City Ordinary are up to 11, and County of London to 8¾, the Preference shares also being better. Other shares are marching on the same road. Brompton and Kensington have improved to 8½, and Westminster Ordinary to 10¼. The season of the year helps adroit advertising of shares in companies which stand to reap advantage from the shortening of the daylight, and, of course, electric lighting shares had fallen to levels which were very low in comparison with previous standards of recent years.

For British Electric Tractions to move in harmony with the two shares first mentioned above, is appropriate enough. The Preference are 9¾, and the Ordinary 5¾. Anglo-Argentine Tramway Ordinary are the features in the traction market, the price rising to 7½ upon dividend anticipation, while the new Ordinary are up to 7 7/16. Buenos Ayres and Belgrano steadied to 3½. Business was done early this week in Metropolitan Electric Tramways Preferred at 17s. 3d., and the Debenture stock changed hands at par. Underground Railways of London profit-sharing Notes strengthened to 91, but Districts are again dull at 23. Metropolitan Consolidated, too, is lower at 65¾.

After being offered at their par value of a sovereign, London Motor Omnibus Ordinary firmed up to 25s., although the 6 per cent. Preference are no better than 3¾. At this price the yield is 8 per cent. on the money, so either the Ordinary are greatly over-priced, or the Preference are exceedingly cheap. Much interest centres in the forthcoming report, now overdue. Other motor-omnibus shares are no better.

In the Telegraph market, all the activity is to be found in Anglo-American Deferred. The sensational dealings in American Railroad shares have imparted renewed buoyancy to the volatile Anglo "A," and the price has been very near to 25. Direct United States Cable shares are 15¾, and Submarine Cable Trust certificates 130½. The Eastern group is inactive. Great Northern Telegraphs are better at 38½, upon the company's announcing that its new cable to Iceland is open for correspondence this week. Cuba Submarine Telegraph shares are scarcely affected by the revolt.

On the other hand, Chili Telephone shares have shed a further fraction, falling to 6⅞, business being transacted as low as 6½. It is, of course, impossible to say yet what may be the effect of the disturbances upon the company, but some proprietors have taken alarm, and as there are only 44,000 shares issued, the market is naturally a restricted one. National Telephones are all slightly better.

Manufacturing shares remain still somewhat neglected, but perhaps the new-found strength in iron and steel shares may not be without its sympathetic effect later on.

Wireless Aeroplane.—According to a Laffan telegram "Mr. Graham Bell's wireless aeroplane on August 26th rose to a height of 200 ft., turned a complete circle, and alighted a few feet from the starting point, with the wireless motors working perfectly. The machine is worked by wireless electrical energy supplied from the earth." On Tuesday last a flight was to be attempted from London (Ontario) to Toronto, "which, if successful, will in the opinion of scientists, prove that in wireless locomotion we have a solution of the problem of aerial flight." These trans-Atlantic flights of fancy leave us breathless.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last four years. 1902.	1903.	1904.	1905.	Closing Quotations Aug 21st.	Closing Quotations Aug. 28th.	Business done week ended Aug. 28th, 1906. Highest	Lowest.	Rise + or Fall —
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	Nil	Nil	Nil	..	3¼ — 4	3¼ — 4	..	..	..
155,600£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	Nil	Nil	Nil	5 %	87 — 92	87 — 92	88¼	..	..
702,500	Anglo-American Telegraph	Stock	60/6	61s.	23%	31%	66 — 68	66 — 68	67⅞	66	..
3,148,700	Do. do. do. 6 % Pref.	Stock	6 %	6 %	5⅝%	6 %	114 —115	113½—114½	114⅞	114	+ ½
3,148,700	Do. do. do. Deferred	Stock	1/-	2s.	Nil	½%	24½— 24½	24½ — 24½	24 1/16	24 1/16	..
50,000	Anglo-Portuguese Tel., 5% Mort. Deb. Stock Red.	100	..	..	..	..	101 —103	101 —103	..	..	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	6 %	7 %	8 %	8 %	6½— 7	6½ — 6⅝	6 5/16	6	— ⅛
1,992,856£	Commercial Cable Stlng. 500 year 4 % Deb. Stk. Red.	Stock	4 %	4 %	4 %	4 %	97½— 99½	97½ — 99½	98¼	98¼	..
16,000	Cuba Telegraph	10	6½%	10 %	5 %	5 %	8¾— 9	8½ — 9	8½	..	..
6,000	Do. 10 % Pref.	10	10 %	5 %	10 %	10 %	17 — 18	17 — 18	..	..	..
12,981	Direct Spanish Telegraph, Ord.	5	4 %	4 %	4 %	4 %	3⅜— 3⅝	3⅜— 3⅝	..	..	..
6,000	Do. do. 10 % Cum. Pref. ..	5	10 %	10 %	10 %	10 %	8½— 9¼	8½ — 9¼	..	..	..
80,000	Do. do. 4½ % Debs.	50	4½%	4½%	4½%	4½%	98 —101	98 —101	..	..	..
60,710£	Direct United States Cable	20	8½%	8 %	8½%	4½%	15½— 16	15½— 16	15 31/32	15⅝	..
65,500	Direct W. India Cable, 4½ % Reg. Deb., 1 to 1,200, R.	100	4½%	4½%	4½%	4½%	100 —102	100 —102	..	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	7 %	144 —147	144 —147	146	144½	..
2,000,000	Do. 8½ % Pref. Stock	100	8½%	8½%	8½%	8½%	90 — 92	90 — 92	91⅝	91	..
1,848,772	Do. 4 % Mort. Deb. Stock Red. ..	Stock	4 %	4 %	4 %	4 %	107 —109	107 —109	108	..	..
800,000	Eastern Extension, Australasia, and China Tele.	10	7 %	7 %	7 %	7 %	14½— 14⅝	14½ — 14⅝	14 5/16	14 5/16	..
759,400	Do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	105 —107	105 —107	..	..	..
800,000	East & S. Afric. Tel., 4 % Mt. Db., 1 to 8,000, red. 1909	100	4 %	4 %	4 %	4 %	99 —101	99 —101	..	..	..
200,000£	Do. 4 % Reg. M. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4 %	4 %	100 —102	100 —102	..	..	..
180,887	Globe Telegraph and Trust	10	£3	5s%	5s%	5s%	10½— 11	10½— 11 xd	10 1/16	10⅛	..
180,887	Do. do. 6 % Pref.	10	6 %	6 %	6 %	6 %	14½— 14⅝	14½— 14⅝ xd	..	..	..
150,000	Great Northern Telegraph, of Copenhagen ..	10	12½%	15 %	24 %	24%	37½— 39½	37½ — 39½	..	..	..
37,900	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,300, Red.	100	4½%	4½%	4½%	4½%	100 —102	100 —102	..	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	13 %	13 %	58 — 60	58 — 60	..	..	..
251,127	Marconi's Wireless Telegraph	1	Nil	Nil	Nil	Nil	⅛— 1 1/16	⅛— 1 1/16	20/6	..	..
72,680	Monte Video Telephone Co., Ltd. Ord.	1	3 %	3 %	4 %	..	⅛— 1	⅛— 1 1/16	..	..	+ 1/16
86,492	Do. do. do. 5 % Pref. ..	1	5 %	5 %	5 %	..	⅛— 1 1/16	⅛— 1	..	..	..
1,988,338	National Telephone, Pref. Stock	100	6 %	6 %	6 %	6 %	108 —110	108½ —110½	1 10	108	+ ½
1,966,667	Do. do. Def. Stock	100	4½%	5 %	5 %	5 %	108 —110	108½ —110½	109½	108	+ ½
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	6 %	11 — 13	11 — 13	11 1/16	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	6 %	10½— 12½	10½ — 12½	..	..	..
250,000	Do. do. 5 % Non-cum. 3rd P., 1 to 250,000	5	5 %	5 %	5 %	5 %	5⅛— 5⅝	5 5/16 — 5 11/16	..	..	+ 1/16
3,000,000	Do. do. 3½ % Deb. Stock Red. ..	Stock	3½%	3½%	3½%	3½%	97½— 99½	98 — 100	99	..	+ ½
1,689,598	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	102 —104	102½ —104½	103⅛	103	+ ⅛
179,318	Oriental Telep. and Elec. 1 to 171,504, fully paid	1	6 %	6½%	6½%	7½%	1⅝— 1 7/16	1 5/16 — 1 7/16	..	..	..
50,000	Do. do. do. 6 % Cum. Pref. ..	1	6 %	6 %	6 %	6 %	1⅝— 1 7/16	1 5/16 — 1 7/16	..	..	..
100,000	Do. do. do. 4% Red. Deb. Stock	100	..	..	..	4 %	97 — 99	97 — 99	..	..	..
100,000	Pacific & European Tel., 4 % Guar. Debs., 1 to 1,000	100	4 %	4 %	4 %	4 %	99 —102	99 —102	..	..	..
11,839£	Reuter's	8	5 %	5 %	5 %	5 %	7½— 7⅝	7½ — 7⅝	7⅝	..	..
60,000	Telephone Co. of Egypt, 4½ % Deb. Red.	100	..	..	..	4½%	101 —104	101 —104	..	..	..
8,201	Submarine Cables Trust	Cert.	6 %	6 %	6 %	6 %	129 —132	129 —132	..	..	..
70,000	United River Plate Telephone	5	7 %	8 %	8 %	8 %	7 — 7½	7 — 7½	7 1/16	..	..
40,000	Do. 5 % Cum. Pref., Nos. 1 to 40,000	5	5 %	5 %	5 %	5 %	5¼— 5½	5¼ — 5½	..	..	..
179,947	Do. do. 5 % Debs.	Stock	5 %	5 %	5 %	5 %	109 —112	109 —112	..	..	..
15,609£	West African Telegraph, Shares	10	2 %	4 %	4½%	4 %	9¼— 10	9¼— 10	..	..	..
80,008	W. Coast of America, 1 to 80,000 & 53,001 to 53,009	2½	Nil	Nil	Nil	Nil	⅜— ⅞	⅜— ⅞	..	..	..
150,000	Do. 4 % Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	4 %	4 %	4 %	4 %	100½—103½	100½ — 103½	..	..	..
207,980	Western Telegraph, Ltd., Nos. 1 to 207,980 ..	10	7 %	7 %	7 %	5 %	14½— 14⅝	14½ — 14⅝	14 5/16	14 5/16	..
75,000	Do. do. 5 % Debs. 2nd-series, 1906	100	5 %	5 %	5 %	5 %	.. — ..	.. — ..	..	..	..
663,380	Do. do. 4 % Deb. Stock Red. ..	100	4 %	4 %	4 %	4 %	103 —106	103 —106	..	..	..
88,321	West India and Panama Telegraph	10	Nil	Nil	Nil	..	⅜— ½	⅜— ½	9/8	..	..
84,563	Do. do. 6 % Cum. 1st Pref.	10	7 %*	7 %*	6 %	5 %	6½— 6⅝	6½ — 6⅝	..	..	..
4,569	Do. do. 6 % Cum. 2nd Pref.	10	Nil	Nil	Nil	Nil	4¼— 5¼	4¼ — 5¼	..	..	..
80,000£	Do. do. 5 % Debs., Nos. 1 to 1,800 ..	100	5 %	5 %	5 %	5 %	99 —102	99 —102	..	..	..

Including arrears.

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

170,000	Anglo-Argentine Trams, 200,006 to 440,007 ..	5	..	..	5 %	5 %	7 — 7⅛	7⅛ - 7⅛	7 1/16	7⅛	+ ⅛
100,000	Do. Nos. 430,008 to 910,007 and 560,008 to 580,007 ..	5	..	..	..	..	6⅞— 7	7 1/16 — 7 1/16	7 1/16	7	+ ⅛
260,007	Do. 5½ % Cum. Prefs., 1 to 260,007 ..	5	..	5 %	5 %	5½%	5⅞— 6	6 — 0	5 23/32	5 11/16	..
266,600	Do. Permanent, 6 % Deb. Stock, 1888	100	..	6 %	6 %	6 %	138 —141	138 —141	..	..	..
285,100	Auckland E. Trams., 5 % 1st Mort. Deb. Stock ..	100	..	5 %	5 %	5 %	102 —104	102 —104	103½	..	..
800,000	Babcock & Wilcox, 1 to 580,000 ..	1	..	17 %	20 %	20 %	3⅞— 4⅛	4 — 4⅛	82/6	81/8	+ ⅛
100,000	Do. do. 6 % Cum. Pref., 1 to 100,000 ..	1	..	6 %	6 %	6 %	1⅛— 1⅜	1⅛ — 1⅜	..	..	..
38,000	British Aluminium, Ord., 2,001 to 40,000 ..	5	..	..	7 %	7 %	3¾— 4	3¾ — 4	..	..	..
40,000	Do. do. 7 % Cum. Pref... ..	5	Nil	Nil	7 %	7 %	6 — 6½	6⅛ — 6⅜	6⅜	6½	+ ⅛
20,000	Do. do. "A" 6 % Cum. Pref. ..	5	Nil	Nil	6 %	6 %	5 — 5½	5 — 5⅛	..	..	..
20,000	Do. do. 4 % Funding Certs. ..	5	..	..	4 %	4 %	4 — 4¼	4 — 4⅛	..	..	..
800,000£	Do. do. 5 % 1st Mort. Deb. Stock Red.	Stock	5 %	5 %	5 %	5 %	101 —105	101 —105	..	..	..
800,000	British Columbia E. Rail Def. Ord. Stock	100	..	6 %	6 %	6 %	117 —120	117 —120	..	..	..
800,000	Do. 5 % Pref. Ord. Stock	100	..	5 %	5 %	5 %	108 —111	110 —113	112⅛	..	..
115,000	Do. 5 % Cum. Perp. Pref. Stock	100	..	5 %	5 %	5 %	105 —108	105 —108	107½	..	..
240,400	Do. 4½ % 1st Mort. Debs., 1 to 6,250 ..	40	..	4½%	4½%	4½%	103 —105	103 —105	..	..	..
220,000	Do. 4½ % Vancouver Power Debs., 1 to 2,200	100	..	4½%	4½%	4½%	101 —104	101 —104	..	..	..
188,801	British Electric Traction	10	8 %	6 %	6 %	3 %	5½— 6	5½ — 6	5⅞	..	..
161,487	Do. do. 6 % Cum. Pref.	10	6 %	6 %	6 %	6 %	9½— 9¾ xd	9½ — 10 xd	9¾	9½	..
1,415,422£	Do. do. 5 % Perp. Deb. Stock	Stock	5 %	5 %	5 %	5 %	112 —115	114 —116	115	..	+1
410,178	Do. do. 4½ % 2nd Deb. Stock Red. ..	100	..	..	4½%	4½%	90 — 93	91 — 94	93½	92½	+1
100,000	British Insulated and Helsby Cables	5	10 %	8 %	8 %	8 %	6¾— 7⅛	6¾ — 7⅛	6 23/32	..	..
100,000	Do. do. 6 % Cum. Pref.	5	6 %	6 %	6 %	6 %	5¾— 6	5¾ — 6	..	..	..
600,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	4½%	4½%	4½%	4½%	102 —105	102 —105	..	..	..
212,000	British Thomson-Houston 4½ % 1st Mort. Debs. ..	100	..	4½%	4½%	4½%	96 — 98	95 — 98	..	..	..
400,000	British Westinghouse 6 % Pref., 1 to 200,000 and 275,001 to 475,000	5	..	6 %	Nil	..	1½— 1⅝	1½— 1⅝	..	..	..
1,016,858	Do. do. 4 % Mort. Deb. Stock ..	100	..	4 %	4 %	4 %	77 — 83	77 — 83	..	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	Nil	Nil	Nil	..	⅝— ¾	⅝— ¾	..	..	..
50,000	¶ Do. do. 6 % Cum. Pref. ..	£1	Nil	Nil	Nil	..	14/6 to 15/6	14/6 to 15/6	..	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731 ..	2	Nil	Nil	Nil	2½%	⅞— 1	⅞ — 1⅛	..	..	+ ⅛
150,000	Do. Non-cum. 6 % Pref.	2	6 %	6 %	6 %	6 %	1¼— 1⅜	1⅛ — 2	33/9	..	+ ⅛
125,000£	Do. 4½ % Perp. Deb. Stock	Stock	4½%	4½%	4½%	4½%	97 — 99	97 — 99	..	..	..
125,000£	Do. 4½ % Perp. 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	82 — 84	82 — 84	..	..	..
100,000	Buenos Ayres & Belgrano, 1 to 100,000	5	..	3 %	4 %	3 %	3⅜— 3⅝	3⅜— 3⅝	70/-	67/6	— 1/16
40,000	Do. "A" 6 % Cum. Pref., 1 to 40,000	5	..	6 %	6 %	6 %	5¼— 5⅜	5¼ — 5⅜	..	..	..
27,500	Do "B" do. 1 to 27,500	5	..	6 %	6 %	6 %	5 — 5⅛	5 — 5⅛	..	..	..
317,700	Do. 5 % Deb. Stock	100	..	5 %	5 %	5 %	104 —106	104 —106	..	..	..
190,000	Do. 5 % 2nd Deb. Stock	100	..	5 %	5 %	5 %	102 —106	102 —105	..	..	..
105,000	Calcutta Trams., 1 to 105,000	5	..	6 %	8 %	8 %	8 — 8¼	8 — 8¼	..	..	..
32,610	Do. 105,001 to 137,610	5	..	..	..	8 %	7¾— 8⅛	7⅞— 8⅛	..	..	..
850,000	Do. 4½ % 1st Deb. Stock	100	..	4½%	4½%	4½%	103 —106	103 —106	..	..	..
35,000	Callender's Cable Construction shares	5	15 %	12½%	12½%	15%	10¾— 11¼	10¾ — 11¼	..	..	..
40,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	5⅝— 5⅞	5⅝ — 5⅞	5⅞	..	..
300,000	Do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	108 —110	108 —110	..	..	..
491,222	Cape E. Trams., 1 to 491,222	1	..	15 %	10 %	5 %	⅝— ¾	⅝— ¾	..	..	..
450,000	Castner-Kellner Alkali, 1 to 450,000	1	..	4 %	4 %	6 %	1 3/32— 1 5/32	1 3/32— 1 5/32	£1/-	..	..
230,211	Do. do. 4½ % 1st Mort. Deb. Stock	100	..	4½%	4½%	4½%	95 —100	95 —100	9⅝	..	..
1,999,698	Central London Railway, Ord. Stock	Stock	4 %	4 %	4 %	4 %	85 — 87 xd	85 — 87 xd	86½	85½	..
630,316	Do. do. 4 % Pref. Stock	Stock	4 %	4 %	4 %	4 %	97 — 99 xd	97 — 99 xd	99¼	..	..
630,316	Do. do. Def. do.	Stock	4 %	4 %	4 %	4 %	73 — 76	73 — 76	75	74	..
480,000	City and South London Railway	Stock	3½%	2½%	2½%	1¾%	44 — 46 xd	45 — 47	45½	44¾	..
85,000	Crompton & Co., Nos. 1 to 85,000	8	5 %	2½%	2½%	2½%	1 1/16— 1 1/8 xd	1 1/16 — 1 1/8 xd	..	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £80 Red.	..	5 %	5 %	5 %	5 %	95 — 98	95 — 98	..	..	..

* A period of nine months. † Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § Interim dividends.
‖ And bonus of 10s. ¶ From Manchester Share List.

(Continued on next page.)

SHARE LIST OF ELECTRICAL COMPANIES.—*(Continued)*

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.—*(continued).*

Present Issue.	NAME.	Stock or Share.	Dividends for the last four years.				Closing Quotations Aug. 21st.	Closing Quotations Aug. 28th.	Business done week ended Aug. 28th, 1906.		Rise + or Fall—
		†	1902.	1903.	1904.	1905.			Highest.	Lowest.	
260,000	Dick, Kerr & Co., 1 to 260,000	1	..	..	10 %	..	1½ — 1⅝	1⅝ — 1¾	34/3	..	..
305,000	Do. do. 6 % Cum. Pref., 1 to 305,000	1	..	6 %	6 %	6 %	1⅝ — 1¾	1⅝ — 1¾	25/7½	24/6	..
294,150	Do. do. 4½ % Deb. Stock	100	..	4½ %	4½ %	4½ %	103 —106	103 —106	..	..	..
60,000	Dublin United Trams. (1896), 1 to 60,000	10	..	5½ %	6 %	6 %	14½ — 15½	14 — 15	..	..	— ½
59,987	Do. 6% Pref. between 1 and 60,000	10	..	6 %	6 %	6 %	14 — 15	14 — 15	..	..	..
99,261	Edison & Swan Utd., "A" shrs., £8 pd., 1 to 99,261	5	Nil	Nil	2½% §	..	1½ — 1⅔	1½ — 1⅔	33/1½	30/7½	..
17,139	Do. "A" shares, 01—017,139	5	Nil	Nil	2½% §	..	2½ — 3	2½ — 3	..	..	..
344,023‡	Do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	85 — 87	85 — 87	..	..	..
100,000‡	Do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	5 %	5 %	5 %	5 %	90 — 95	90 — 95	..	..	..
119,100	Electric Construction 1 to 119,100	2	6 %	4 %	Nil	Nil	¼ — ⅓	¼ — ⅓	..	..	..
81,890	Do. do. 7 % Cum. Pref., 1 to 81,890	2	7 %	7 %	7 %	7 %	1¾ — 2¼	1¾ — 2¼	..	..	..
200,000	Do. do. 4 % Perp. 1st Mort. Deb. Stk.	Stock	4 %	4 %	4 %	4 %	86 — 89	86 — 89	..	..	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	5 %	9 — 9½	9 — 9⅝	..	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	4 %	4 %	4 %	4 %	93 — 97	93 — 97	..	..	..
78,000	Gt. N. & City Rail Pref. Ord. "A" 4 % 1 to 78,000	10	..	3 %	4 %	4 %	3½ — 3⅝	3¾ — 4	..	..	+ ¼
96,000	Greenwood & Batley 7 % Cum. Pref.	10	..	7 %	7 %	7 %	10¼ — 10¾	10½ — 10¾	..	..	..
80,000	Do. do. 5 % Mort. Debs.	100	..	5 %	5 %	5 %	100 —102	101 —102	..	..	+ ½
200,000	Henley's (W. T.), Telegraph Works, Ord.	5	20 %	15 %	15 %	15%	12 — 13	12 — 13	12⅝	..	..
200,000	Do. do. 4½ % Pref.	5	4½%	4½%	4½%	4½%	5⅜ — 5⅝	5⅜ — 5⅝	..	..	..
41,978	Do. do. 4½ Mort. Deb. Stock	Stock	4½%	4½%	4½%	4½%	107 —109	107 —109	..	..	..
108,022	Do. do. Scrip. All paid	..	..	..	..	..	107 —109	107 —109	..	..	..
60,000	India-Rubber, Gutta-Percha & Telegraph Works.	10	10 %	10%	5 %	10%	17 — 18	17 — 18	17⅝	..	..
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	12½ %	13%	Nil	1⅞ — 1 7/16	1⅞ — 1 7/16	..	..	..
10,000	† Do. do. Pref. £10 paid	10	5 %	5 %	5 %	5 %	4½ — 6½	4½ — 6½	..	..	..
600,070	London United Trams (1901), 1 to 50,007	10	..	8 %	6 %	3 %	8 — 8½	8 — 8½	..	..	..
399,930	Do. do. 60,008 to 100,000 (£6 paid)	10	..	8 %	6 %	3 %	4 — 5	3½ — 4½	..	..	— ½
125,000	Do. do. 5 % Cum. Pref., 1 to 125,000	10	..	5 %	5 %	4 %	8⅝ — 8⅞	8⅝ — 9½	9	8⅝	+ ⅝
1,331,000	Do. do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	93 — 96	94 — 97	..	..	+1
314,016	Metropolitan Electric Trams, Defd.	1	Nil	Nil	Nil	3 %	⅛ — ¼	⅛ — ¼	..	..	— 1/16
500,000	Do. 5 % Cum. Pref.	1	5 %	5 %	5 %	5 %	13/16 — 15/16xd	13/16 — 15/16	17/3	16/3	..
350,000	Do. 4½ % Deb. Stock Red.	100	..	..	4½%	4½%	100 —102	100 —102	100	99¼	..
20,000	Peebles (B.) & Co. 6 % Cum. Pref., 20,001 to 40,000	5	..	..	6 %	6 %	4⅞ — 5½	4⅞ — 5½	..	..	..
24,500	Potteries E. Trc., 20,001 to 40,000 & 50,001 to 54,500	10	..	5 %	5 %	4 %	6½ — 7½	6½ — 7½	..	..	..
24,500	Do. 5 % Cum. Pref., 1 to 20,000 & 40,001 to 44,500	10	..	5 %	5 %	5 %	7½ — 8½ xd	7½ — 8½	..	..	..
245,000	Do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	100 —103	100 —103	..	..	..
37,350,	Telegraph Construction and Maintenance	12	20 %	20 %	15 %	15 %	33½ — 35½	33½ — 35½	34⅛	..	..
150,000‡	Do. 4 % Deb. Bds., 1 to 1,500 Red. 1909	100	4 %	4 %	4 %	4 %	100 —102	100 —102	..	..	..
3,599,200	Undergd. E. R., Lon., 5 % Profit Shar. S. Nts.	..	..	..	5 %	5 %	90 — 92	90 — 92	90½	90	..
540,000	Waterloo & City Railway, Ord. Stock	100	3½%	3½%	3½%	3½%	101 —104	101 —104	..	..	..
66,666	Willans & Robinson, 1 to 30,000 & 80,001 to 116,666	5	8½%	3 %	Nil	Nil	⅜ — 1½	⅜ — 1½	..	..	..
66,666	Do. 6 % C. P., 30,001 to 80,000 & 125,001 to 141,666	5	..	6 %	Nil	Nil	2⅜ — 3½	2⅜ — 3½	..	..	..
246,806	Do. 4 % 1st Mort. Deb. Stock	100	..	4 %	4 %	4 %	77 — 82	77 — 82	..	..	..

ELECTRICITY SUPPLY COMPANIES.

14,000	Bromley (Kent) E.L. & P., 1 to 14,000	5	..	5 %	5½%	4 5/8 %	5⅛ — 5⅜	5⅛ — 5⅜	..	..	..
60,000	Do. do. 4½ % 1st. deb. stock	100	..	4½%	4½%	4½%	101 —104	101 —104	103½	103½	..
29,377	Brompton & Kens. Elec. Lt. Sup., Ord., 1 to 30,000	5	8 %	10 %	10 %	10 %	7⅞ — 8⅛ xd	8 — 9xd	..	..	..
10,623	Do. do. 7 % Cum. Pref.	5	7 %	7 %	7 %	7 %	7⅞ — 8 xd	7⅞ — 8xd	..	..	..
800,000	Central Electric Supply 4 % Guar. Deb. Stock	100	4 %	4 %	4 %	4 %	100 —103	101 —104	91/3	..	+1
80,000	Charing Cross and Strand Electricity Supply	5	10 %	8 %	8 %	5 %	4 — 5 xd	4½ — 5xd	..	..	+ ¼
80,000	Do. do. 4½ % Cum. Pref.	5	4½%	4½%	4½%	4½%	4⅜ — 4⅞ xd	4⅜ — 4 7/16xd	..	..	— ⅛
40,000	Do. "City Undertaking" 4½ % Cum. Prf.	5	4½%	4½%	4½%	4½%	4 — 4½	4 — 4½	..	..	..
40,000	Do. do. 1908	5	..	4½%	4½%	4½%	4 — 4½	4 — 4½	82/6	..	..
420,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	4 %	101 —104	101 —104	104½	102	..
44,486	Chelsea Electricity Supply, Ord.	5	4½%	5½%	6 %	6 %	5½ — 5⅝	5½ — 5⅝	5 11/16	..	..
175,000‡	Do. do. 4½ % Deb. Stock Red.	Stock	4½%	4½%	4½%	4½%	106 —108	106 —108	107½	..	..
70,595	City of London Elec. Lighting, Ord. 40,001—110,595	10	5 %	5 %	6 %	6 %	10⅜ — 10⅝	10⅜ — 11⅛	11	10⅜	+ ⅛
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	6 %	11⅜ — 12½	12 — 13	12½	..	+ ½
400,000‡	Do. 5 % Db. Stk., Scrip. (iss. at 115) all pd.	..	5 %	5 %	5 %	5 %	123 —126	123 —126	..	..	..
800,000	Do. 4½ % 2nd Db. Stk., Prov. Crts., all pd.	100	4½%	4½%	4½%	4½%	100 —103	100 —103	..	..	..
40,000	County of Durham Electrical Power, Ord.	2	4 %	4 %	£3 7 0	4 %	2⅛ — 3 3/16	2⅛ — 3 3/16	..	..	..
50,000	Do. do. do. 5 % Pref.	5	5 %	5 %	5 %	5 %	5 — 5⅛	5 — 5⅛	..	..	..
40,000	County of London Electric Lighting, Ord. 1—40,000	10	4 %	4 %	4½%	5 %	8 — 8¼ xd	8¼ — 9 xd	8 9/32	..	+ ⅛
80,000	Do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	6 %	11½ — 12½ xd	11½ — 12½xd	11⅞	11⅞	..
400,000‡	Do. do. 4½ % Deb. Stock	..	4½%	4½%	4½%	4½%	107 —110	107 —110	..	..	..
400,000	Do. do. 4½ % 2nd Deb. Stock	Stock	4½%	4½%	4½%	4½%	101 —104	101 —104	..	..	..
80,000	Edmundson's Electric Corporation, Ord. Shares	5	7 %	7 %	7 %	4 %	3½ — 3⅝	3½ — 3⅝	5 3/32	..	..
80,000	Do. do. 6 % Cum. Pref.	..	6 %	6 %	6 %	6 %	4¾ — 5⅛	4¾ — 5⅛	..	..	..
820,000	Do. do. 4½ % 1st Mort Deb. Stk	100	4½%	4½%	4½%	4½%	100 —103	100 —103	..	..	..
10,000	Folkestone, 1 to 10,000	5	..	5½%	5½%	5½%	5⅜ — 5⅝	5⅜ — 5⅝	..	..	..
10,000	Do. 5 % Cum. Pref., 1 to 10,000	5	..	..	..	5 %	5 — 5⅛	5 — 5⅛	..	..	..
75,000	Do. 4½ % 1st. Deb. Stock	100	..	4½%	4½%	4½%	99 —102	99 —102	..	..	..
18,000	Hove, 1 to 18,000	5	..	8½%	8½%	9 %	7⅞ — 8¼	7⅞ — 8½	..	..	+ ⅛
10,000	Do. New (£6 10s. paid)	£3	..	8½%	8½%	9 %	6⅛ — 6⅞	6½ — 7	..	..	+ ⅛
87,300	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	99 —101	99 —101	..	..	..
7,300	Do. 4½ % Deb. Stock	100	..	4½%	4½%	4½%	99 —101	99 —101	..	..	..
21,000	Kensington and Knightsbridge Electric Ord.	5	10 %	12½	12 %	10 %	9⅞ — 10⅛	9⅞ — 10⅛	10⅛	..	..
90,000	Do. do. do. 4 % Deben. Stk.	Stock	4 %	4 %	4 %	4 %	98 —101	98 —101	..	..	..
111,000	London Electric Supply Corporation, Limited, Ord.	3	Nil	Nil	3 %	4 %	1⅞ — 2⅛	1⅞ — 2⅛	..	..	..
60,000	Do. do. do. 6 % Pref.	5	6 %	6 %	6 %	6 %	5 — 5⅛	5 — 5⅛	..	..	..
874,395	Do. do. 4 % 1st Mort. Deb. Stk. Red.	Stock	4 %	4 %	4 %	4 %	96 — 99	96 — 99	..	..	..
200,000	Metropolitan Electric Supply, 1 to 100,000	5	7½%	8½%	10 %	10 %	8 — 9 xd	8⅝ — 8 7/16xd	8⅝	8⅛	+ ⅛
76,121	Do. 4½ % Cum. Pref. 1—71,106, £3 pd.	5	4½%	4½%	4½%	4½%	5⅛ — 5⅜	5⅛ — 5⅜	5 9/32	5 5/32	..
220,000‡	Do. 4½ % 1st Mort. Deben. Stock	..	4½%	4½%	4½%	4½%	109 —113	109 —113	..	..	..
250,000‡	Do. 3½ % Mort. Deben. Stock Redem.	Stock	3½%	3½%	3½%	3½%	95 — 97	95 — 97	96	..	..
250,000	Midland Electric Corporation, 4½ % 1st Mort. Deb.	100	4½%	4½%	4½%	4½%	98 —101	98 —101	..	..	..
75,000	Newcastle-on-Tyne, 1 to 75,000	5	..	8 %	8 %	8 %	7⅞ — 8	7⅞ — 8	..	..	..
75,000	Do. 5 % Pref., 1 to 75,000	5	..	5%	5 %	5 %	5⅝ — 6⅛	5⅝ — 6⅛	..	..	..
10,852	Notting Hill Electric Lighting	10	6 %	6 %	7 %	7½%	13½ — 14½	13½ — 14½	..	..	..
64,000	Do. do. 4 % 1st Mort.Deb.	100	4 %	4 %	4 %	4 %	97 — 99	97 — 99	..	..	..
18,500	Oxford, 1 to 96 and 407 to 18,810	5	..	6½%	7 %	7 %	6⅜ — 6⅝	6⅜ — 6⅝	..	..	..
50,000	Do. 4 % Deb. Stock	100	..	4 %	4 %	4 %	98 —100	98 —100	..	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	12½%	10¼ — 11¼	10¼ — 11½	..	..	+ ¼
20,000	Do. do. 7 % Pref. 20,001 to 40,000	5	7 %	7 %	7 %	7 %	6⅞ — 7⅛	6⅞ — 7⅛	7	..	..
160,000‡	Do. do. 3½ % Deb. Stock Red.	100	3½%	3½%	3½%	3½%	95 — 97	95 — 97	..	..	..
12,000	Smithfield Markets Electric Supply, Ord.	5	2½%	4 %	4 %	4 %	2 — 2½	2 — 2½	..	..	..
60,000	Do. do. 4 % Deb. Stock	Stock	4 %	4 %	4 %	4 %	74 — 78	74 — 78	..	..	..
65,000	South London Electricity Supply, Ord.	5	12½%	8 %	4 %	4 %	2⅜ — 3½	2⅜ — 3½	..	..	..
103,700	South Met. Elec. Lt. & Power (Ord.	1	Nil	Nil	Nil	2½%	1 1/16 — ⅛	1 1/16 — ⅛	..	..	..
85,368	*(Late Blackheath and Greenwich Dist. E.L.Co.)* 7 % Pref.	1	Nil	7 %	7 %	7 %	1⅛ — 1⅜	1⅛ — 1⅜	..	..	..
148,299	*(Late Blackheath and Greenwich Dist. E.L.Co.)* 4½ % 1st Deb. Stk.	100	4½%	4½%	4½%	4½%	103 —106	103 —106	..	..	..
50,000	Urban Electric Supply, Ord.	5	5 %	5 %	5 %	5 %	3½ — 4	3½ — 4	..	..	..
30,000	Do. do. 5 % Cum. Pref.	5	5 %	5 %	5 %	5 %	4½ — 5	4½ — 5	..	..	..
200,000	Do. do. 4½ % 1st Mort. Db. Stk. Red	100	..	..	4½%	4½%	98 —101	98 —101	..	..	..
110,000	Westminster Electric Supply, Ord.	5	12½%	12½%	14 %	13 %	9⅛ — 10⅛ xd	9⅞ — 10⅜xd	10⅜	10⅛	+ ⅛
28,151	Do do. 4½ % Cum. Pref. (Originally 5 %—Red. to 4½ % from 31st Dec., 1906.	5	5 %	5 %	5 %	5 %	5½ — 5⅝	5½ — 5⅝	5 7/16	5 5/32	..

Shares not officially quoted:—Mackay Companies, ord., 75—77. Pref. 75—77.

† Unless otherwise stated all shares are fully paid. § Interim dividends.

(Bank rate of discount 3½ per cent. June 21st, 1906).

EXPORTS AND IMPORTS OF ELECTRICAL GOODS DURING JULY, 1906.

The fluctuating character of our electrical import and export business is emphasised by the returns for the month of July, the totals under all three sections having mounted up much above the average.

As regards the exports, which attained the satisfactory total of some £140,000, the amount is the second highest recorded in the past 18 months and nearly £12,000 in advance of the same month's figure in 1905.

The imports show a similarly improved total, standing at £144,000 approx., which compares with £106,000 in July, 1905.

The re-exports at £11,823 are as much above the average as the July returns of last year—viz., £4,648—were below it.

Of the individual items, exports of electrical and electrically driven machinery are together practically at the same level as in the preceding month, while imports of electrical machinery show an advance of nearly £17,000 in value. The exports of cable were nearly double those in June; the imports show a decrease.

The imports of telephonic and telegraphic material at £37,873 show an increase of some £9,000 on the previous month, Belgium contributing £22,000 worth, and Sweden £10,000 worth to this amount. Our exports at nearly £4,000 show a considerable improvement.

A small import of tramway material from Belgium also appears.

Registered Exports of British and Irish Electrical Goods from the United Kingdom.

Country receiving exports and importing.	Electrical goods and appliances.	Electrical cable.	Electric lighting fittings and accessories.	Electric lamps.	Electric meters and instruments.	Electric machinery.	Batteries and accumulators.	Carbons.	Telegraph and telephone material, and electric bells.	Electrically-driven machinery.	Tramways apparatus and materials.
	£	£	£	£	£	£	£	£	£	£	£
Russia, Sweden, Norway and Denmark	1,298	3,012	285	21	51	987	3	...	310	54	...
Germany	486	24	19	...	...	42	...	...	180	...	...
Netherlands	17	4,802	421	...	40	161	31	...	...	142	...
Dutch Borneo, Java and Indian Possessions ...	155	...	...	...	...	13	...	...	...	23	...
Belgium	475	...	93	17	39	95	...	...	797	...	...
France	87	...	35	2	11	543	107	...	20	6	...
French Indo-China	2	...	8	24	...	...	...	...	...	11	...
Portugal, Madeira and Portuguese Africa ...	315	1,915	305	33	9	807	...	3	60	...	...
Spain and Canary Isles	209	...	...	40	...	1,207	16	...	...	215	...
Italy	10	...	12	50	859	9	...	...	...	...	...
Greece	...	...	...	...	...	53	...	...	...	...	...
Egypt	1,018	401	141	...	...	1,366	...	...	6	1,106	...
China and Siam	122	1,221	840	444	9	1,569	169	...	123	195	...
Japan	573	3,177	569	1,741	3,041	6,215	...	16	...	452	...
U.S.A.	504	...	23	...	...	191	23	...	...	...	...
Mexico	360	159	139	...	...	171	87	...	...	3,320	...
Columbia, Peru and Uruguay	78	...	12	48	5	2,762	...	19	...	70	...
Chili	386	236	286	17	...	48	7	36	41	...	...
Brazil	278	399	311	243	19	775	...	...	39	...	...
Argentine	2,731	4,871	747	40	380	4,220	967	10	1,196	2,599	...
Channel Isles, Gibraltar and Malta	280	747	234	27	...	1,782	5	...	20	...	...
British West Africa	126	28	14	7	17	36	2	...	27	25	...
Cape of Good Hope	2,646	495	550	164	296	4,368	9	151	115	740	...
Natal	970	1,164	1,181	959	74	875	100	14	26	1,637	...
Mauritius	...	...	65	7	...	71	...	...	...	...	...
India	3,238	4,463	895	279	1,960	5,492	350	21	535	584	...
Burmah	52	693	51	...	...	39	...	...	50	16	...
Ceylon	56	413	180	...	...	153	14	...	...	...	...
Straits Settlements, Fed. Malay States and Labuan	380	808	562	89	56	1,467	70	26	78	26	...
Hong Kong	170	376	123	34	...	406	22	152	125	25	...
West Australia	900	113	273	46	431	1,045	46	24	...	...	...
South Australia	169	...	...	...	11	1,599	...	...	...	...	...
Victoria	150	665	12	20	218	1,774	100	...	...	...	...
New South Wales	1,447	246	379	515	50	1,292	46	30	15	726	...
Queensland	25	140	181	...	...	48	...	54	...	...	...
New Zealand	317	421	608	93	57	1,231	56	...	11	312	...
Canada and Newfoundland	265	...	70	9	26	952	...	3,238	...	...	...
Brit. W. Indies and Brit. Guiana	60	28	35	...	79	55	...	...	169	...	...
Total, £	20,355	31,017	9,659	4,969	7,738	43,919	2,230	3,794	3,943	12,284	...

Registered Imports into the United Kingdom of Electrical Goods from all Countries.

	£	£	£	£	£	£	£	£	£	£	£
Russia, Norway, Sweden and Denmark	5	242	40	85	...	216	103	4	10,634	...	...
Holland	224	2,330	669	3,274	55	12,256	501	6,162	521	...	...
Germany	350	4,122	788	266	25	8,080	710	228	2,905	...	...
Belgium	698	1,849	1,023	3,287	27	6,358	605	2,565	22,136	112	914
France	2,876	5,452	1,865	781	1,412	1,528	218	3,444	1,500	...	...
United States	2,547	1,080	470	53	...	25,425	84	158	177	503	...
Canada	...	...	...	...	...	...	...	...	...	4	...
Total, £	6,700	15,075	4,855	7,746	1,519	53,863	2,221	12,561	37,873	619	914

Registered Re-Exports of Foreign and Colonial Electrical Goods from the United Kingdom.

	£	£	£	£	£	£	£	£	£	£	
Various countries, mainly as above	3,682	1,149	520	94	416	927	1,048	270	3,682	35	...

Total Exports:	Total Re-Exports:	Total Imports:
£139,908	£11,823	£143,946

Note.—The amounts appearing under the several headings are classified according to the Customs returns. The first and third columns contain many amounts relating to "goods" otherwise unclassified, the latter, doubtless, consisting of similar materials to those appearing in adjacent columns.

PROCEEDINGS OF INSTITUTIONS.

Long Flame Arc Lamps.

By Leonard Andrews, A.M.I.C.E., Member.

(*Abstract of Paper read before the* Institution of Electrical Engineers, *April 26th*, 1906.)

Until comparatively recently all tests and experiments made with arc lamps appeared to show conclusively that to obtain the highest efficiency the length of the arc should not exceed three or four millimetres; but whilst increasing the length of the arc beyond three or four millimetres does tend to reduce the efficiency of arc lamps with coaxially arranged pure carbons, this rule does not apply to many of the long flame arc lamps having inclined downward feeding carbons which have now begun to be very generally used.

Taking the mean of the results given by different authorities, and reducing them all to a common basis by making the necessary corrections for globes and different standards of illumination, it appears that the relative efficiencies expressed in mean hemispherical British candle-power of the different types of lamps are approximately as follows:—

	Candle-power per ampere.	Candle-power per watt.
Ordinary open arc	82	1·54
Enclosed arc...	55	0·77
Carbone H.T. arc	200	2·24
Chemical carbon arc ...	259	5·80

It is an interesting fact that all the very marked improvements that have been made in arc lighting during recent years have been effected by the use of arcs from 10 to 15 millimetres in length, and investigation shows that the great improvement in efficiency is directly or indirectly due to this increased length.

The improvements effected may be briefly summarised as follows:—

(*a*) The formation of the positive crater in such a position that none of the light emitted by it is obstructed by the negative carbon.

(*b*) The impregnation of the carbons with metallic salts, thereby rendering the flame highly luminous.

Engineers who attended the demonstration of electrical apparatus at Hastings about three years ago will remember that considerable attention was attracted by a Carbone arc lamp, which was taking the same current as an ordinary 10-ampere arc lamp burning by its side, but the new lamp appeared to be giving between two and three times the light; the pressure across the terminals was about 85 volts. As the arc was giving a remarkably white and steady light, and was not burning in an enclosed globe, this high voltage excited considerable interest.

It is well known that the maximum illumination obtainable from a pure carbon arc lamp in any direction is proportional to the area of the positive crater visible in such direction, plus the light emitted by the red-hot portions of the carbons, the white spot on the negative, and the flame or arc mist; and since the area of the crater is approximately proportional to the current and is not appreciably increased by an increase of voltage, it would appear, at first sight, that to expend energy on an increase of voltage must tend to decrease the efficiency. It must be remembered, however, that for all practical purposes it is not so much the actual area of the crater that determines the useful efficiency of an arc as the area visible at any angle below the arc.

Mr. Trotter has shown that if none of the light from the positive crater is intercepted, then the candle-power from this source at any angle may be represented by the radius vectors of a circle drawn to such a scale that the diameter of the circle is proportional to the candle-power measured directly facing the crater.

To be able to calculate and plot the candle-power from the area, the intrinsic brilliancy of the positive crater must, however, first be determined. This has been found by three different authorities to be 146 c.p., 158 c.p., and 170 c.p. respectively per square millimetre, and as the mean of these results is 158 c.p. per square millimetre, it appears reasonable to take this figure for calculating the candle-power of the positive crater from its area. There is, however, also to be taken into consideration the fact that the intrinsic brilliancy of the soft core portion of the crater is considerably less than that of the hard carbon portion, and probably does not exceed 100 c.p. per square millimetre.

Mrs. Ayrton found the total area of a 10-ampere, 45-volt crater to be approximately 18 square millimetres, of which 7 square millimetres were soft core and 11 square millimetres were hard carbon. The total maximum candle-power emitted by a 10-ampere positive crater, calculated on the above basis, would appear to be 2,438 c.p.

Objection has been raised to the use of polar curves for showing the efficiency of an arc, on the ground that the mean spherical candle-power cannot be calculated directly from these curves. It is, however, even more impossible to determine the useful efficiency of an arc from knowledge of its mean spherical candle-power only. For instance, the mean spherical candle-power of a direct-current arc would be approximately the same, whether the positive crater were at the top or at the bottom, whereas it is well known that in the majority of cases the *useful* efficiency is enormously reduced by what is known as connecting up a lamp the wrong way.

A polar curve giving the candle-power at any angle is the more useful guide to an engineer selecting arc lamps for any given purpose than the bare information that a certain type of lamp has an efficiency of a certain mean spherical candle-power per watt.

Not only is a very large proportion of the total light emitted by the positive crater of an open arc intercepted by the negative carbon, but the waste from this cause occurs in the direction in which, for many purposes, it can least be spared. It is evident, therefore, that a very large economy can be effected by causing the positive crater to form in such a position that, whatever angle it be viewed from, none of it shall be cut off by the negative carbon.

Mr. Carbone appears to have been the first to suggest that the solution of this difficulty was the use of inclined carbons combined with a voltage of from 80 to 90 volts across the arc; he also discovered a method of controlling the long arc without flickering, and succeeded in obtaining a form or shape of flame which reduces to a minimum the absorption of the light from the crater by the arc mist. Fig. 1 shows the ends of the carbons and the economiser of a "Carbone" arc lamp.

The Carbone method of controlling the position of the arc, shown in fig. 2, consists of a closed iron magnetic circuit, the only field affecting the arc being that due to magnetic leakage from this closed circuit. The chief leakage will obviously be from the ends of the cores carrying the exciting solenoids. Holes are drilled in the iron ring midway between the points to which it is fixed to the core, thereby increasing the magnetic reluctance, and causing further leakage, at points approximately at right angles to the cores. The result is a weak hemispherically-shaped leakage field of just sufficient strength to maintain the craters at the tips of the carbons, the shape of the flame covering the mouth of the economiser somewhat resembling that of a soap bubble covering the bowl of a tobacco pipe under very slight pressure.

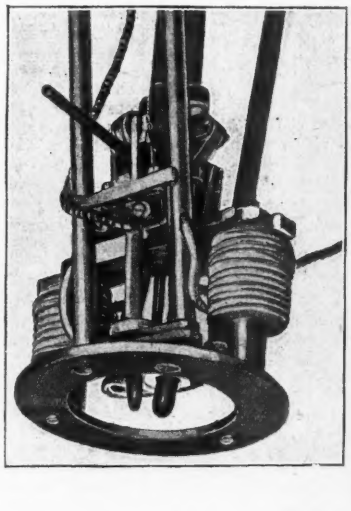
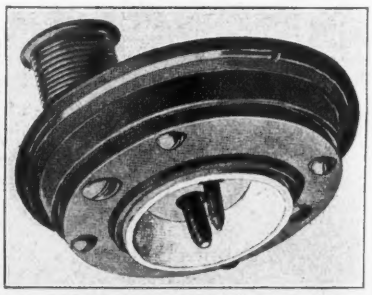
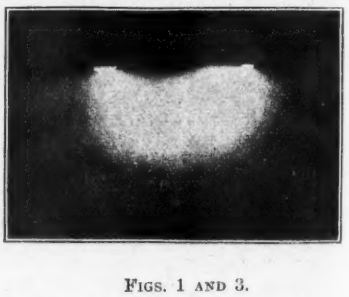


Fig. 2.





Figs. 1 and 3.

Fig. 3 is reproduced from a photograph of a 10-ampere 85-volt "Carbone" arc, the incandescent tips of the carbons being just visible below the edge of the economiser. The dense portion of the flame is the violet mist, which is very similar in appearance and colour to the mist seen between the carbons of every arc lamp. This mist is surrounded by a sheath or envelope of burning gases.

Unlike the ordinary arc lamp, the length of the arc mist to be traversed by the crater light is not appreciably increased by lengthening the arc. It would appear, therefore, that by ascertaining the area of the crater visible in a given direction for voltages ranging from 45 to 100 volts, it should be possible to ascertain to what extent the high efficiency of the "Carbone" arc is directly due to the fact that the higher voltages cause the crater to form more at the tips of the carbons.

From a number of photographic views of the craters of carbon lamps, the author deduces that with voltages of less than 60, the crater forms between the carbons, and whilst the actual area is approximately the same as that of a similar current 90-volt arc, the area visible is only a fraction of the total area.

In the case of two arcs in parallel, a given voltage will maintain a considerably longer arc between a soft core positive carbon and the negative, than between a hard carbon and the negative.

To form the craters at the tips of the carbons, a pressure of from 80 to 90 volts is required, and no useful improvement in the position of the craters is obtained by increasing the pressure of a 9 or 10-ampere arc above 90 volts.

From two curves of the areas of the craters visible directly below the arc with different voltages, it is seen that the "Carbone" lamp has a very different characteristic to the corresponding curve given by Mrs. Ayrton for coaxially arranged carbons. This reaches a maximum at about 42 volts, and then steadily falls, whereas the "Carbone" efficiency curve continues to show a marked improvement up to 80 volts.

It has so far been assumed that the candle-power emitted by the positive crater is proportional to the area of such crater, and that no appreciable proportion of the light emitted is intercepted by the arc mist.

The positive crater area of a 9·3-ampere 89-volt "Carbone" arc was found to be 17·1 square millimetres, of which 3 square millimetres was of soft-cored crater. The candle-power emitted by the positive crater, plus that emitted by the negative or white spot, should therefore be :—Hard carbon positive crater 14·1 sq. mm. × 158 = 2,227·8, soft-cored positive crater 3·0 sq. mm. × 100 = 300·0, negative crater 1·5 sq. mm. × 158 = 237·0; total, 2,764·8.

The polar curve, fig. 4, shows that the candle-power derived from the craters is considerably smaller than Dr. Wedding's curve plotted from the mean of actual candle-power measurements taken at a number of different angles and in different vertical planes. We have, however, to add to the candle-power derived from the

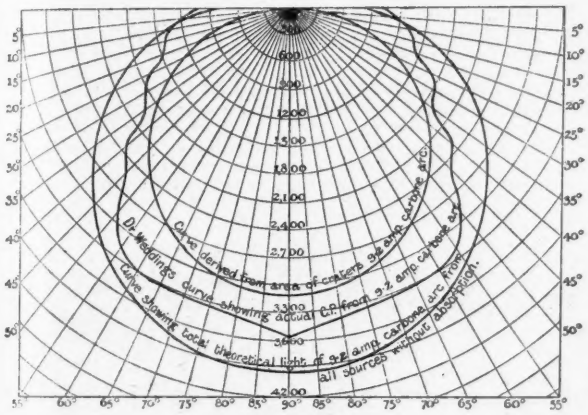

Dr. Wedding's curve showing actual C.P. from 9·2 amp. carbone arc
Curve derived from area of craters 9·2 amp. carbone arc
Curve showing total theoretical light of 9·2 amp. carbone arc from all sources without absorption.

FIG. 4.

area of the craters the candle-power of the flame and of the red-hot portions of the carbons. Dr. Wedding found the mean candle-power measured in the same horizontal plane as that occupied by the craters to be approximately 900, which added to the radii of the polar curve gives the third or outer curve.

It would appear, then, that the light intercepted by the arc mist is represented by the difference between the outer curve and Dr. Wedding's curve of actual results.

By far the chief source of light in a pure carbon arc is the positive crater; it would appear that of the total candle-power of 2,750 hemispherical candle-power emitted by a 10-ampere chemical carbon arc, less than 700 C.P. is emitted by the positive crater. Whilst, therefore, the high efficiency of this type of arc is in a measure due to the formation of the craters in such a position that none of the light from the positive crater is intercepted by the negative carbon, it is evident that it is only partially due to this cause.

The crater area of a chemical carbon arc is in a great measure dependent upon the portion of the carbon that is being consumed at the time. The movement of the crater causes considerable difference in the pressure across the arc, the total variation sometimes amounting to as much as 15 per cent. It is interesting to note that, owing apparently to the lower resistance of a chemical carbon arc, the craters can be retained at the tips of the carbons with a very much lower voltage than is required for a pure carbon arc.

Another noticeable difference between chemical carbon arcs and pure carbon arcs is to be found in the drop of potential across the positive crater.

The bulk of the light from a chemical carbon arc emanates from the flame, and is apparently due to minute burning particles in the flame which are raised to a very high state of incandescence. It has been found that the relative intrinsic brilliancy of the flame of a chemical carbon lamp is about one-third that of the positive and negative craters.*. It must be remembered, however, that the area of the flame visible at any angle is many times that of the crater, and the total light emitted by the flame is consequently many times that emitted by the craters.

The efficiency of a chemical carbon lamp is so very much higher than it has yet been possible to attain with any type of pure carbon arc that it might appear at first sight that the use of pure carbons would very soon cease. Unfortunately, however, the advantage from the point of view of efficiency is discounted by certain defects which render this type of lamp unsatisfactory for many purposes.

The flickering noticeable in all chemical carbon lamps cannot at present be entirely overcome, though it has been greatly reduced in recent lamps. The carbons are now usually of the composite type, consisting of three zones. The outer zone or envelope is composed of pure carbon, giving mechanical strength. The next contains carbon mixed with various salts—such as those of calcium and magnesium—and the inner soft centring core is made of the same materials less strongly compressed.

The poisonous fumes given off by the burning chemicals make the lamp unsuitable for use in a room not very efficiently ventilated, besides which, these fumes are very apt to injure the mechanism of the lamp.

The ash or residue from a chemical carbon arc is very much greater than from a pure high-voltage flame arc lamp.

The carbons are at present considerably more costly than pure carbons, and as the globes cannot be entirely enclosed, the life of the carbons is very short. The light is useless in positions where discrimination of colours is required.

The nearest approach to a pure white light that has yet been attained by artificial means appears to be that of the high-pressure pure carbon arc with downward-feeding inclined carbons. That it is so, however, is somewhat surprising, as it would be expected that the very long flame of the high-voltage arc would give a very violet light.

Sir W. Abney has shown that the light emitted by the positive crater of a pure carbon arc lamp is very like sunlight, but has a slight excess of orange and green rays and a slight deficiency of blue. Notwithstanding this generally accepted fact, it is well known that the light from an ordinary arc lamp tends to make objects appear to be blue or purple, particularly when the arc is long. Mrs. Ayrton attributes this blueness to the fact that a portion of the light from the crater in passing through the flame of the arc is reflected and refracted by minute particles of incandescent carbon, and as these carbon particles absorb the red and green rays and allow the violet rays to pass, the light emitted by the flame or carbon mist is of a deep violet colour. It would appear, therefore, that if just the correct quantity of this violet light could be mixed with the direct light from the crater, which, as has been shown, is deficient in violet rays, the result would be an exact reproduction of sunlight. In the ordinary direct-current arc a large percentage of the crater light is intercepted by the negative carbon, whereas, owing to the very much larger area of the flame, comparatively little of the light from it is so intercepted. The resultant mixture, therefore, contains far more violet rays than are required to produce a pure white light.

The fact that none of the crater light of the "Carbone" arc is intercepted may, at any rate partially, account for the pure whiteness of this light.

It must be remembered that the general public do not judge of the efficiency of any system of lighting by taking photometric tests. It would probably be much better for the electrical industry if they did. Their usual method of judging a light is, first to look at the source of light, to satisfy themselves that there is a large area of light-giving surface, and secondly, to examine the ground directly below the lamp they are judging. The engineer, however, recognises that it is of even greater importance to know what is the minimum illumination midway between lights than it is to know the maximum illumination directly below the arc.

It is well known that at least 40 per cent. of the light emitted by an arc lamp is intercepted by the opalescent globe. This waste appears to be necessary, in the first place, to prevent the dazzling effect which would result from an unscreened arc fixed at a position that comes within the natural angle of sight, and in the second place to give a diffused light, or the effect of a light emitted from a large surface. The screening effect, however, need not be considered if the source of light can be placed at such a height above the ground that it does not come within the natural angle of sight. It appears that for many purposes, such, for instance, as for lighting large buildings, where the source of light can be placed 30 ft. or 40 ft. above the ground, it is unnecessary to use densely obscured globes. It is suggested that for this purpose long flame arc lamps should be used, fitted with globes of which the lower half is unobscured.

Alternating-current lamps are very unpopular in this country on account of their very low useful efficiency. Dr. Wedding has found that the efficiency of an alternating-current lamp of the long flame downward-feeding carbon type is practically similar to that of a direct-current arc of the same type.

The author has obtained a photograph showing the area of craters of a 10-ampere pure carbon high-voltage arc, the current being 10 amperes, voltage 67, and the area of the craters 15·3 square millimetres. The watts per square millimetre of crater area are therefore 44. They are consequently no greater for this alternating-current arc than for a 10-ampere direct-current arc.

Another objection to alternating-current arcs is that, when connected across an alternating-current circuit of less than 50 cycles per second, the flickering is very objectionable. It appears that this difficulty may also be considerably lessened by using downward-feeding carbon arcs, in which both craters are visible directly below the arc. As in the ordinary coaxially arranged carbon arc only one crater is visible from any position during one entire half of each cycle, there must of necessity be a dark period between each flash of light. An experiment described by the author appears to show that a downward-feeding carbon lamp on a 50-cycle circuit gives the same effect as an ordinary lamp on a 100-cycle circuit.

Discussion.

Mr. A. P. Trotter, in opening the discussion, pointed out with reference to the author's table of relative efficiencies that the results were not comparable unless the lamps were all measured on

* *Science Abstracts*, No. 662, 1905.

the same basis, viz., ampere—the watt basis was even more difficult, owing to varying pressure. In regard to intrinsic brilliancy, he had obtained results varying between 64 C.P. and 170 C.P. per sq. mm., and the latter might be exceeded. He thought the curve (fig. 4) might easily be wrong by 30 per cent., owing to many causes not considered by the author, and that the light intercepted by the negative carbon in uniaxial lamps was somewhat over-estimated. In regard to colour, he maintained that the ordinary arc was really a pale straw colour (by day), and it was an illusion that it appeared blue at night.

Mr. HAYDN T. HARRISON agreed that the mean hemispherical candle-power had been increased by the Carbone lamp, but the downward candle-power had also been increased, and that was not wanted. The speaker had always tried to obtain an increased horizontal distribution of light. The quality of the carbons used greatly affected results; he asked whether commercial types of carbon were used on the author's lamp. The flame arcs, particularly the chemical varieties, gave just the luminous flame which was wanted, and that constituted their increased efficiency over the ordinary arc.

Mr. DUDDELL asked what was meant by soft-cored carbons? Did they contain some foreign body? as he had found that a hard core, such as glass, enabled a lower voltage arc to be maintained. He did not think the arc absorption was so large as was supposed, and suggested that a knowledge of the exact shape of field required with the Carbone lamp would be valuable.

Mr. LEON GASTER discussed the flame arc; it was certainly efficient, and in regard to the so-called poisonous fumes, he thought more definite information was required. He did not believe that lamp globes were responsible for absorption to the extent generally thought.

Mr. JUSTUS ECK suggested that the term candle-power per ampere was not wanted. He asked whether there was any air circulation over the carbons of the Carbone lamp, and what was the temperature of the arc? In regard to the yellow flame arc, he had found no ill effects in a building where 100 such lamps were used, and as a rule where such a high candle-power was employed there was good ventilation.

Mr. HOADLEY thought that in small towns there were few places where 850-watt lamps could be used, but a 250-watt flame arc would meet with success in such places. He had experienced no trouble from either flickering or chemical fumes, and thought the pale yellow-coloured light was much preferred for outside work.

Mr. W. H. PATCHELL, referring to the competition with gas, remarked that the railway authorities at Charing Cross had tried five "Oriflamme" arcs against eight high pressure gas lamps, and on the basis of price the former gave 45,000 C.P. against 20,000 C.P. for gas. He gave the energy cost per 1,000 mean hemispherical candle-power-hours, with various lamps as follows:—Oriflamme, 350-watt, ·4d.; Excello, 470-watt, ·57d.; Santoni, 420-watt, ·7d.; Carbone, 1,000-watt, 1d.; ordinary open type, 500-watt, 1½d.; and enclosed, 500-watt, 2d. Referring to the extensive use of arc lighting in the States, he said that, owing to the universal use of enclosed arcs, one man could trim 600 lamps against one man to, say, 40 lamps here. Further, the American engineer did not know what high-pressure gas was. He believed from trials that the magazine lamp was the coming thing. There was no flickering in his experience with the Oriflamme lamp. The cost of carbon with the chemical flame arc was ·09d. per lamp-hour, an amount not very different from the ordinary carbon arc.

Mr. COWAN, referring to the Carbone lamp, said that by enclosing the arc he had got the life up to 53 hours, though this introduced some flickering. Mr. Carbone, however, had obtained 300 hours' life with a lamp which he was introducing, but not a magazine lamp. In regard to the magnetic field round the arc, he thought the latter was pushed out, which would account for its shape; the crater area would be greater owing to the greater temperature obtained with 80 volts as compared with 45 volts pressure. Neither he nor Dr. Schwartz (of Manchester) who had tested the lamp, could detect the slightest colour difference in comparison with "Manchester daylight."

After Mr. W. M. MORDEY had indulged in some historical reminiscences, Mr. LEONARD ANDREWS replied to the discussion. He pointed out that Mr. Trotter's figure for intrinsic brilliancy was very different from those of other authorities. He considered that an excessive horizontal distribution of light in street lighting was bad for the eyes, and referred to an example of lighting in Berlin, where groups of flame arcs mounted on 50-ft. poles gave an excellent illumination.

Electric Power Development in the United States.

—An American contemporary states that the following hydro-electric undertakings are now being carried out in the Southern States:—The Withney Company, of Withney, N.C., is erecting a power station, to have a capacity of 40,000 H.P., on the Tadkin River; the Chattanooga-Tennessee River Power Company is putting down a 42,000-H.P. plant on the Tennessee River; the Southern Power Co., of Charlotte, N.C., is erecting a 75,000-H.P. water-power plant; the Southern Light and Power Co., of Atlanta, Ga., is proposing to develop about 100,000 H.P.; the Columbus River Co. has authority to establish a plant of 75,000 H.P.; and a new undertaking has recently been established on the Roanoka River, at Eagle's Ferry, by the Eagle Falls Light and Power Co.

THE BRITISH ASSOCIATION.

Radiation Phenomena, and their Bearing on Radiation Pyrometry.

By Prof. J. B. HENDERSON, D.Sc.

(*Abstract of Paper read before Section G, August 8th*, 1906.)

THE laws of radiation which have been developed theoretically and confirmed experimentally are four in number, and apply to the radiation from any ideal black body. They are—

1. $\int_0^\infty E\,\lambda\,d\lambda = \sigma\,T^4$ (σ being a constant) Stefan-Boltzman law.
2. $\lambda_m\,T$ = constant.
3. $E_m\,T^{-5}$ = constant. } Wien's law of displacement.
4. $E\,\lambda = \dfrac{a\,\lambda^{-5}}{\epsilon^{\frac{b}{\lambda T}}-1}$, ($a$ and b being constants) Planck's law.

of the partition of energy in the spectrum.

λ_m is the wave-length of maximum radiant energy in the spectrum, E_m the value of the maximum radiant energy, and T the absolute temperature. The expression proposed by Wien for the partition of energy in the spectrum differs from Planck's only in omitting the figure unity in the denominator, and may be interchanged with Planck's if $\lambda\,T$ is less than 3,000.

The above laws are developed theoretically from Maxwell's electro-magnetic theory and the laws of thermo-dynamics.

All accurate radiation thermometry is founded on these four laws; hence, wherever accuracy in radiation thermometry is required it is very important to remember the limitations of the laws—namely, that they apply only to the radiation from an *ideal black body*. Kirchhoff showed that the radiation inside an enclosure whose walls are at uniform temperature is the same as would be emitted by an ideal black body at the same temperature; and by using the radiation from cavities whose walls were heated electrically to uniform temperatures, the theoretical laws have been experimentally proved.

If, then, we wish to obtain accurately the temperature of any material in a furnace by means of the radiation which it emits, we must take the radiation from a cavity whose walls are at the required temperature. If the material is in liquid or pulverous form, a tube closed at one end serves the purpose if the closed end is inserted in the material and the radiation taken from the closed end. If the material is in ingot form and there is no serviceable hole in it, we can use an auxiliary piece of similar material provided with a hole, and placed against the ingot, so as to have practically the same temperature as the ingot. The hole or cavity may bottom against the ingot or in the auxiliary piece of material.

To use a radiation pyrometer in the tempering of armour plate on a cooling curve, it would be necessary to lay another plate with holes in it on the one to be tempered, then heat the two together in the furnace, and after withdrawing them from the furnace to focus the thermometer on the bottom of one of the holes. When the required temperature was indicated the upper plate could be removed and the lower one quenched, the upper one being returned to the furnace with the next plate.

In every case where the temperature is read while in the furnace, it is necessary to shield the radiation from luminous flames after

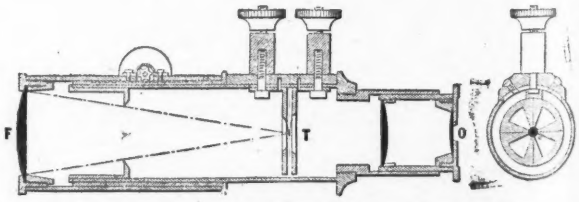


FIG. 1.—FÉRY RADIATION PYROMETER: REFRACTING TYPE.

leaving the cavity. This may be done by means of tubes, and the temperature of the walls of these tubes will not affect the result, provided an image of the cavity is formed on the sensitive surface of the thermometer.

The principles on which the present radiation pyrometers are founded are the first and fourth laws. Those founded on the fourth law we may distinguish from the others by the term optical thermometers, because only the luminous portion of the spectrum is used.

Pyrometers based on Law I have a black receiving surface for absorbing the radiation from the radiating body. This surface may be one of the junctions of a thermo couple, or the wires of a bolometer or one arm of a radiometer balance, but as we are more concerned with instruments used in the industries than with those used in the laboratory, the following descriptions will be confined to the former.

Figs. 1 and 2 show two types of Féry pyrometers. In fig. 1 the image of the radiant is formed on the receiving surface by means of a fluorite lens F, although in some technical forms a particular kind of glass having low absorptive power in the infra red is used for the lens. The temperature of the receiving surface is measured

by a thermo-couple T and portable galvanometer. This pyrometer lacks sensitiveness at temperatures below 900° C., and to increase the sensitiveness Féry replaces the lens by a concave mirror M, making a reflecting telescope, as shown in fig. 2. This form can measure down to 600° C. The eye piece O in both instruments is for sighting purposes, as an image of the radiant must be formed on the small receiving surface of the junction. So long as this image is larger than the receiving surface the reading of the pyrometer is independent of the distance from the radiant, because both the total radiation received by the lens or mirror and the area of the image vary inversely as the square of the distance from the radiant, hence the intensity of the image is constant.

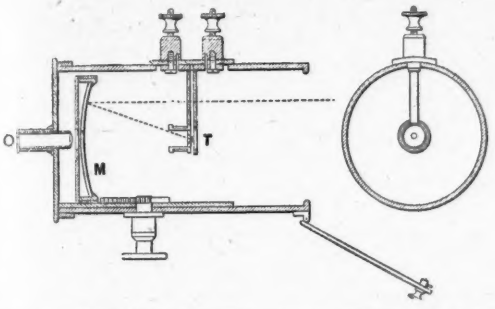


Fig. 2.—Féry Radiation Pyrometer: Reflecting Type.

In a perfect pyrometer of this kind the receiving surface should be ideally black, and in some researches Lummer and Pringsheim have used cavities as receiving surfaces. The error introduced in a practical instrument due to this defect is, however, not of great significance. The accuracy of the Féry instrument is within 1 per cent. between 800° C. and 1,600° C., with ideal black radiation.

Law IV gives us the equation connecting the radiant energy with temperature along an isochromatic curve. This may be written—

$$\log E = c + \frac{d}{T} \text{ where } c \text{ and } d \text{ are constants.}$$

If, then, we confine our attention to one luminous wave length—say, the red line transmitted by red copper oxide glass, and plot log E as a function of 1/T, we get a straight line. This is the scientific foundation of all optical pyrometers. It may be easier to calibrate them empirically, but it would be possible to calibrate them by means of this equation.

Optical thermometers are simply spectro-photometers of simple form.

The most practical is that due to Holborn and Kurlbaum, which is shown in fig. 3. An image of the radiant is formed in the focal

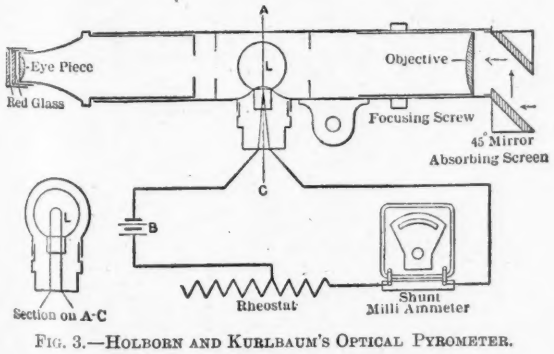


Fig. 3.—Holborn and Kurlbaum's Optical Pyrometer.

plane of a telescope, and is there superposed on the filament of a small electric lamp L, placed in the focal plane A C. The current in the filament is then varied until the filament, as viewed through the eye piece of the telescope, cannot be distinguished from the image of the radiant. The current in the filament then forms a measure of the temperature. To standardise the instrument each lamp is first of all aged and then calibrated to get the connection between the current and the temperature of the filament. In measuring very high temperatures the radiation is weakened by dark glasses or by successive reflection, the glasses or reflecting surfaces being also standardised. Red glass is used in front of the eye piece.

Suction Gas Plants.

By Prof. W. E. Dalby, M.A., B.Sc.

(*Paper read before Section G, August 7th*, 1906.)

I have been asked many times during the last few weeks the question, "What is a suction gas plant exactly?" with an emphasis on "exactly." There is good excuse for this question, because these plants have become practicable sources of motive power only within the last three years. Three years ago it is probable that only one or two firms in the country would have undertaken to supply a plant and guarantee its action. At the recent trials held at Derby in connection with the Royal Agricultural Show, 14 plants were entered for the competition, and with few exceptions they all ran well.

Fig. 1 is a diagrammatic representation of a plant. The gas current through the plant is put on the rack, as it were, and stretched out to a straight line. To the right of the diagram will be seen the engine cylinder, which acts as a pulse to the system. When the piston moves out to the right, the pressure is reduced all

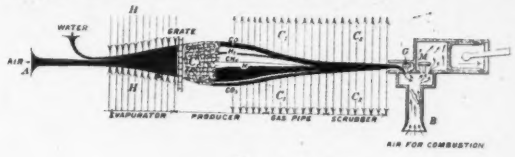


Fig. 1.

through the plant, and air is drawn in at the points A and B. Confining our attention to the air entering at A, it makes its way through what may be called the "tube," and receives heat in the region marked H, thus increasing its capacity to absorb moisture. Water enters in this region, and the heated air, acting as a sponge, saturates itself with water vapour, and then passes on to the grate of the producer, where it passes through an anthracite or coke fire. It will be observed that at this stage the quantities entering into this process for 1 lb. of carbon are 4·5 lb. of air and about 0·084 lb. of water. Chemical changes now take place, and the air and the absorbed moisture become transformed after the passage through the fire into a gas containing, roughly, 29 lb. of carbonic oxide, 1½ lb. of hydrogen, ½ lb. of methane, 57 lb. of nitrogen, and 12 lb. of carbon dioxide per 100 lb. The density of the gas in this state is small, and therefore, if it were taken direct into the cylinder, a charge of small energy value would be obtained. It is therefore necessary to cool the gas down to something like the atmospheric temperature during its passage through the region C_1, C_2. The gas then in some cases emerges into an expansion chamber placed close to the engine. Examining now more particularly the cylinder end of the apparatus, and assuming a suction stroke to be taking place, the gas enters through the valve G into a chamber which is in direct communication with the air; consequently the suction produced by the piston draws into this chamber, and from thence into the cylinder, not only gas from the producer through the valve G, but the quantity of air necessary to make it into an explosive mixture through the air-pipe B. The quantity of air through the air-pipe B is controlled by a valve, which is set in a definite position. The mixture of gas and air passes into the cylinder through the valve M, and is compressed during the return stroke of the engine until, at a suitable point, it is fired by an electric spark obtained by breaking the circuit through which a current flows, the current being derived from a magneto of the Simms-Bosch type, mounted on the side of the engine, and operated by a pin on the cam-shaft. Thus the movement of the piston to the right causes a flow of air and steam into the apparatus at the left, which undergoes a series of complicated chemical reactions in the producer part, and, at the same time, draws gas from the apparatus and combines it with a suitable mixture of air to form the explosive mixture. At the end of this suction stroke the producer is cut off from connection with the engine by the closing of the valves G M, and the remaining three strokes of the Otto cycle

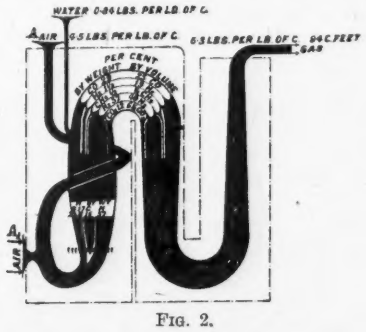


Fig. 2.

are completed. These operations are all perfectly straightforward, and present no apparent difficulties. But the extraordinary feature of the suction plant is, that an engine can go on working continuously, and these operations can go on minute after minute, hour after hour, and day after day, so that the explosive mixture made in the mixing chamber, and the power developed by the cycle of operations in the cylinder, are automatically regulated to enable the engine to run on a variable load without the necessity of altering the position of a single valve or handle.

It will be observed (fig. 1) that heat is taken into the system in the region H, and is expelled again in the regions marked C_1 and C_2, and it will be at once apparent that if heat is to be taken away from region C, and is to be introduced in the region H, the apparatus may be so constructed that the heat required at H is that taken from the heat rejected at C, thus introducing the principle of regeneration.

Fig. 2 illustrates how the gas stream is coiled upon itself in order to realise this regenerative principle. It will be seen that the water and the air, after being drawn into the system at the point marked A by the suction of the engine, absorb heat from the part of the stream from which heat must of necessity be withdrawn, the two parts of the stream being separated in this region by a suitable heating surface. The part of the apparatus in which this interchange takes place is sometimes called the boiler, more generally the evaporator. It will be observed that a supplementary supply of air is taken in a little lower down at A_1. The purpose of this will be explained later in connection with Messrs. Crossley's plant. The air saturated with moisture passes through the fire of the producer, and the general composition of the gas produced is shown at the top of the diagram. The composition by volume is also shown. The gas passes down the gas-pipe into the scrubber and cooler, emerging at the proper density for the engine. The figures given refer to the analysis of Dowson gas, published by Mr. Dugald Clerk in his "Gas Engine," and are not materially different from the composition of gas given by the producer plant. It will be observed that 1 lb. of anthracite, neglecting the ash, combines with 4·5 lb. of air and 0·84 lb. of water to produce 6·3 lb. of gas, equal to 94 cb. ft., and that the calorific value of this is equal to 148 B.TH.U.

Fig. 3 shows an actual producer arranged to carry out this process, made by Messrs. Crossley Bros., of Manchester. Coal is fed to the hopper at the top, and makes its way down to the incandescent part of the fire, so that the fire is practically working under a head of coal. The arrangement causes the incandescent part of the fire which extends from the grate surface to just below the bottom of the hopper, to be constantly fed with warm dry fuel, and, at the same time, the gases driven off from the fuel in the lower part of the hopper, called a distilling and distributing bell, are acted upon by the incandescent fuel so as to prevent the formation of tar. The evaporator or boiler is placed so that hot gas

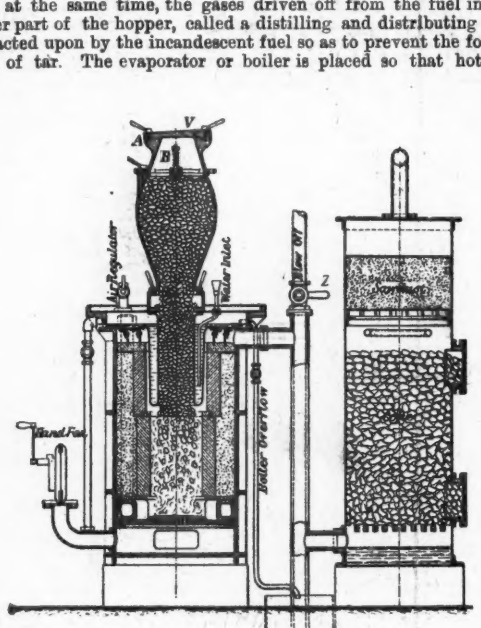


Fig. 3.

as it goes from the fire circulates round it on its way to the gas pipe. Air is taken in at the top, and fills the space above the water level in the boiler, and a constant trickle of water through the tap maintains the water level approximately constant. The saturated air is drawn down through two air pipes embedded in the packing at the back of the furnace lining. A further regulated supply of air is drawn in below the grate, and the air then streams upwards through the fire, and the gas therein produced passes round the boiler, and produces the necessary evaporation of water for saturating the incoming air with steam; then it passes away through the gas pipe to the scrubber, where it is cleaned and cooled, finally emerging from the scrubber in a state suitable for use in the engine. Any fine particles which may be carried by the gas stream—dust and so forth—are shot down into the water seal. Sawdust is put into the scrubber to catch any tar that may come through.

Fig. 4 shows a more contorted gas stream. It will be seen, however, that all that has happened is that the gas, and at the same time the water stream, take an additional turn round the hot gas stream. They are then introduced into the generator, where again heat is abstracted from the hot gas still further to heat the air and water together. The action of the producer in other respects is in general the same as that of the other described.

Fig. 5 shows the producer arranged by the National Gas Engine Co. to carry out these operations. Very little description is necessary, because in all essential principles the producer is the same as the one last illustrated. It will be observed that the increased regenerative action is obtained by introducing the air into a roughly helical passage E, F at the point marked D, which winds round the pipe carrying the hot gas from the producer to the scrubber, and then finds its way into an annular space heated by the gas as it leaves the fire. The water is introduced into a species of Field tube placed in the centre of the gas-pipe and emerges hot at Q_1 where it trickles through the funnel into the

Fig. 4.

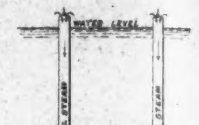


Fig. 6.

annular space in which the hot air is circulating. The water trickling into this space is held by various ribs, as seen, so that the air gets properly saturated before it flows down the air and steam pipe K into the space below the grate, from which it is drawn through the fire where it is chemically changed, and the hot gas produced passes away, as before, through the scrubber to the engine.

It will thus be seen that there are several ways in which the gas stream may be twisted upon itself, and the arrangements necessary to give a mechanical environment to these contorted streams result in different forms of producers, which are all essentially the same in principle, however much they may differ in appearance. The producers are all modifications of the original Dowson pressure producer, the chief modification being in the use of the regenerative principle to avoid the use of a separate boiler to generate the steam required in the producer.

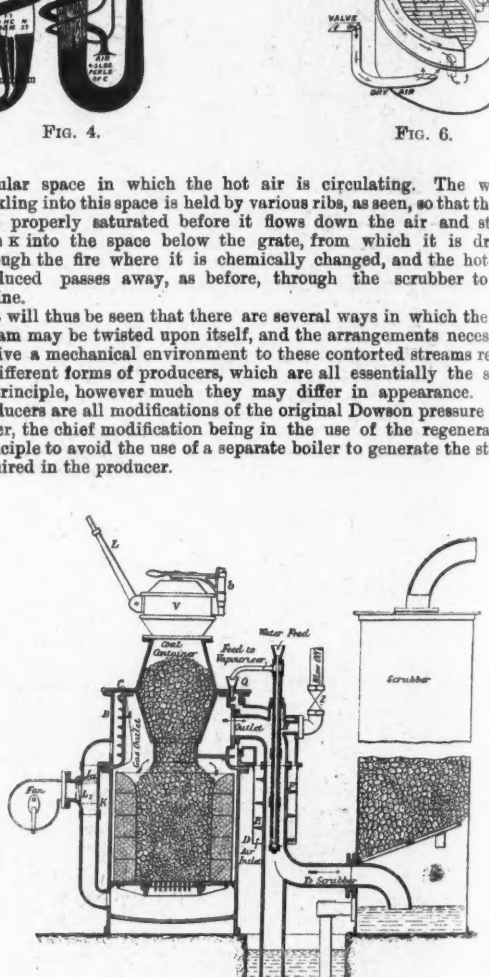


Fig. 5.

At the present time there does not appear to be a definite relation between the proportions of the furnace of the producer and the power to be produced. The incandescent part of the fuel occupies the vertical space between the level of the grate and the bottom of the inverted cone which guides the fuel down from the hopper to the fire, and the height of this space, which is the thickness of incandescent fuel through which the air and steam are drawn, is about 2 ft. in the case of producers designed for engines of from 15 to 20 H.P. The area of the cross-section of the furnace averages about 0·065 to 0·075 sq. ft. per B.H.P. The capacity of the furnace, reckoned as the cubic contents of the space between the fire-bars and the bottom of the distributing and distilling cone, is 2·37 cb. ft. in the case of the 20-H.P. producer of the National Co., illustrated in fig. 5. In the Crossley design, shown in fig. 3, the capacity is 1·58 cb. ft. for 15 B H.P. These figures reduce to 0·118 cb. ft. and 0·105 cb. ft. per B.H.P. respectively. The diameter of the furnace in the "National" design is 15½ in. for a 20-H.P. furnace, and in the Crossley design 12 in. for a 15-H.P. furnace, giving actual areas of 1·31 sq. ft. and 0·785 sq. ft. respectively. These figures correspond to furnace areas of 0·065 and 0·075 sq. ft. per B.H.P. The depth of the fire in the case of the "National" engine is 1 ft. 10 in., and in the case of the Crossley producer it is 2 ft.

In order to produce a continuous supply of gas the producer must be designed so that fuel can be introduced into the furnace without at the same time introducing air; the water required for regulating the quality of the gas should be supplied from the external source at a constant rate, and the rate of combustion

in the furnace should be constant, and the fire should be uniformly hot.

In order to fulfil the first condition the fuel is introduced into the distilling and distributing bell through a hopper, whose design may be likened to the old grease-cock used for getting grease into an engine steam-chest. There are two valves, one giving communication between the interior of the hopper and the furnace, and the other giving access to the hopper from outside. Without going into the general details of hopper design, figs. 3 and 5 illustrate two typical examples. The outer valve V, fig. 5, simply slides off horizontally about the vertical axis marked *b*, the inner one is a heavy valve something like a mitre-valve, and it is operated by the lever L. The process of charging the furnace is to close the inside valve, and then to charge the hopper through the outer valve, and, after closing the outer valve or lid, to open the inner valve by means of the lever L, and so allow the fuel to fall into the distilling and distributing cone. In the case of the design shown in fig. 3, the upper part A of the hopper turns about the vertical pin B. The top of this movable part is provided with a lid V, through which the fuel is introduced into the hopper. Then a turn of the hopper brings the holes in its base opposite to the holes in the fixed part of the hopper, and so allows the fuel to drop into the distributing cone.

The hoppers, in fact, are so arranged that they form a gas or air lock. At the same time they prevent air from getting in, and they prevent gas from getting out during the charging process.

The second condition of steady working—namely, that the water should be supplied at a constant rate—is easily fulfilled by placing a small tank, provided with a ball valve, on the main supply pipe, at a convenient height above the producer, and using this tank for the supply of the producer water only. In this way the water is supplied at a constant head, and once having adjusted the supply cock to give the quantity necessary, the rate of flow will remain constant, because the head is constant. If the supply is taken direct from the water main, the variations of head in the main produce corresponding variations in the flow, and make any accurate regulation of the water supply impossible.

The third condition of steady working requires that the supply of air and steam should take place at a regular rate. This supply is determined entirely by the engine, and when the engine is working steadily on its load the suction strokes follow one another regularly, with the exception that when the action of the governor prevents the gas valve from opening, the suction stroke is not felt through the producer, but only through the pipe which supplies air to the mixing chamber of the engine, in which air is mixed with the gas drawn from the producer to form an explosive charge.

This regular supply of air and water to the furnace causes a permanent *régime* to be established with regard to temperature, so that the gas which is produced is of regular quality.

Nothing disturbs the regularity of working so much as the clinkering of the fuel. Clinker in the fire prevents the supply of air from spreading uniformly through the incandescent fuel, and thus causes irregularity of the fire, which in its turn causes irregularities in the quality of the gas. The quantity of air passing through the fire gets gradually less as the obstruction caused by the clinkers gradually increases. If clinkering cannot be altogether prevented, that which is formed should be of a friable nature, so that it can easily be removed without damage to the furnace lining.

The formation of clinker can be minimised by keeping the temperature of the fire relatively low, and this is accomplished by the steam which is introduced in the air supply. Part of the steam drawn in with the air is dissociated in the furnace into hydrogen and oxygen, this being an endothermic process in which 62,000 British thermal units per pound of hydrogen dissociated are withdrawn from the furnace. The steam has, therefore, a cooling action upon the furnace, and hence prevents high temperature, and prevents, therefore, the formation of clinker. It may be said in passing that this action of the steam in keeping the furnace cool is one of the leading principles in the Mond producer, the object aimed at being to keep the furnace so cool that the nitrogen which is produced by distillation from the bituminous coal used is not dissociated, and may therefore be subsequently recovered and turned into ammonium sulphate.

When the engine is working at a lighter load the number of suction strokes per unit of time is decreased, and consequently the amount of air drawn through the furnace, and therefore the heat produced in the furnace per unit of time, is reduced. Herein lies one of the difficulties in the correct proportioning of suction-gas plants, because if all the load is thrown off the engine for a short time, the air drawn through may be insufficient to keep the fire in a condition to produce good gas. An engine which is to work occasionally on a full load, and very often on a light load, may be advantageously combined with a furnace of relatively small diameter. When running on a light load with a furnace suitably proportioned for running continuously at full load, the few suction strokes made with the gas valve open may not draw sufficient air to keep the fire properly hot. This difficulty is sometimes evaded by fitting a by-pass between the gas pipe and the mixing chamber of the engine. When the cock on the by-pass is open there exists a small permanently open passage between the gas pipe from the producer and the mixing chamber. Consequently, at every suction stroke of the engine a small quantity of air is drawn through the fire, and of necessity also a small quantity of gas through the by-pass into the mixing chamber, and from thence into the cylinder; but this quantity is not sufficient to form an explosive mixture with the air drawn through the air pipe of the engine at the same time. The exhaust, therefore, always contains a small proportion of gas when the engine is running light with the by-pass open. In this way the fire can be maintained in an active condition, and full load can be put on at any time without trouble.

In the trials which were recently conducted at the Royal Agricultural Show at Derby, one day was devoted to testing the engines on variable loads. Each engine was required to run for two hours on no load, and then to change to full load for one hour, after which all the load was taken off, and the engine continued running for an hour on no load, at the end of which time one-third load was applied for an hour, and then half-load for an hour; finally full load was applied for the last two hours of the trials. It should be understood that the engines were not allowed to stop during these changes of load. The run was a continuous one of about eight hours. The automatic action of the plant is sufficiently evidenced by the fact that in some cases not a handle was touched during the whole day; nothing was done, in fact, but to charge the hopper with fuel at intervals and to change the load on the brake. This automatic regulation is obtained by varying the amount of steam drawn through the fire as the demand on the producer varies. For instance, when running at light load, as has already been explained, a small quantity of air is drawn through the fire at every suction stroke by means of the by-pass, and the temperature in the producer is therefore relatively low, therefore the incoming air is cooler, and carries less steam with it. Consequently the gas produced is not so rich. As the demand on the engine increases, more air is drawn through per unit of time, the temperature rises, the incoming air is warmed to a greater extent, more steam is carried through with it, and the gas produced is richer.

In the producer (fig. 5) the variation of the temperature of the evaporator in consequence of the varying quantity of air drawn in per unit of time is relied upon to vary the quantity of steam in such a way that the richness of the gas is proportioned to the demand on the producer. The air-supply pipes and the grate in the producer used by Messrs. Crossley are shown diagrammatically in fig. 6. It will be noticed that the air is taken in in two streams, one stream coming in charged with steam from the boiler, the other stream being practically dry air which is introduced directly under the grate through the supplementary air valve. The quantity of steam in the total air supplied depends, therefore, on the relative proportion of air composing the two streams, and this is adjusted by properly setting the valve on the supplementary air supply.

It would take too much time to describe the devices fitted on the various plants for regulating the proportion of steam in the air, but they all have for their object the increase of the water supply when the load on the engine increases.

Passing on now to the method of starting a plant, after the fire is lighted air is blown into the ash-pit by means of a small fan. Blowing is maintained for from 15 to 30 minutes, when the plant is starting up from a cold condition, and during this operation the valve Z is open to the chimney, so that whatever is being produced passes away without going into the scrubber or into the engine, and the valve L_2 is turned into the position L_1. Small test-cocks are fitted near the producer, and also near the engine, and blowing is continued until the gas will light, and maintain itself alight, at these test-cocks. When the gas produced is of this quality, the chimney valve is closed, blowing is stopped, the valve in the air-pipe is turned into the position L_2, and a turn or two at the fly-wheel is sufficient to start the engine. Full load can be put on within a few minutes of starting. In all the 14 designs sent in for competition at the Royal Show, the fan was placed on the air side of the grate, so that whilst blowing up for starting the plant acted as a pressure-plant, and it was not until the engine started that the pressure in the producing system fell below the atmosphere.

The actual consumption of anthracite per brake-horse-power is not an easy quantity to measure, because the producer holds such a large quantity of fuel in proportion to the quantity burnt per hour. It is then difficult, unless on an extremely long run, to eliminate the starting and stopping errors. Assuming a 20-B.H.P. plant to start on Monday morning with an empty producer, and to run 10 hours per day on full load for a week, banking the fires at night, the consumption of anthracite peas would be about half a ton for the week, and about three-eighths of a ton if the average load is about half full load. With coke the consumption is about 25 per cent. more. From 2,000 to 3,000 gallons of water per week are required for a 20-B.H.P. plant to provide water for the scrubber and the producer, and of this by far the larger part would be used in the scrubber.

The gas produced contains a large amount of carbonic oxide, which is of a very poisonous nature, and being inodorous, its escape cannot be detected. With a pressure plant any leak in the joints, of course, allows the gas to escape into the atmosphere, and very serious consequences may easily follow to those in attendance. With a suction plant, on the contrary, air leaks inwards, and danger from poisonous gas is small, provided the plant is installed properly. Should sufficient air leak inside to cause an explosion, the water seal would blow out, and thus act as a safety valve. The water seal thus serves the double purpose of collecting dust brought down the gas pipe and of acting as a safety valve.

Action for Damages.—The National Telephone Co. was sued by the parents of a youth named T. O. Evans for damages under the Employers' Liability Act, the youth having been killed by a fall from a pole whilst in the service of the company. Judge Lumley Smith remarked on the danger of the work, but found no evidence of negligence on the part of the company, and therefore gave judgment for the defendants. The plaintiffs then made a claim under the Workmen's Compensation Act, and the judge postponed his decision. An offer of £60 had been rejected by the plaintiffs.

NEW PATENTS APPLIED FOR.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

15,200A. "Improvements in supporting the plates of secondary batteries." A. E. Segnitz and W. E. Parkes. (Date applied for under Rule 5 of the Patents Rules, 1905, July 4th, 1906.) August 17th.

18,096. "'Magnetic' floating and moving objects." C. J. Murray. August 13th.

18,119. "Improvements in dynamos and motors." H. Lacy. August 13th. (Complete.)

18,120. "Improvements in electric motors." H. Lacy. August 13th. (Complete.)

18,135. "Improvements in or relating to instruments for indicating the flow of currents of electricity through conductors." S. J. Ross. August 13th.

18,156. "Improvements in means for the regulation of electrical machines." J. Y. Johnson. (Felten & Guilleaume Lahmeyerwerke Akt.-Ges., Germany.) August 13th. (Complete.)

18,168. "Apparatus for transmitting synchronous and equal movements to a distance." Siemens Bros. & Co., Ltd., and F. Turner. August 13th.

18,179. "Improvements relating to electric installations working with turbo-dynamos and accumulators." M. Grob. (Date applied for under Patents Act, 1901, September 19th, 1905, being date of application in Switzerland.) August 13th. (Complete.)

18,186. "Improvements in and relating to systems of electric motor control." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) August 13th.

18,187. "Improvements in and relating to electric resistance regulators." Allgemeine Elektricitats-Gesellschaft. (Date applied for under Patents Act, 1901, August 14th, 1905, being date of application in Germany.) August 13th. (Complete.)

18,211. Improvements in trolley finders." W. J. Hinton. (Date applied for under Patents Act, 1901, August 16th, 1905, being date of application in United States.) August 14th. (Complete.)

18,212. "Improvements in telegraphic and telephonic apparatus for establishing communication between signal boxes and trains on the line." J. A. F. Hall. August 14th.

18,220. "Improvements relating to the utilisation of wind power for generating electricity for lighting or other purposes." G. Broughall. August 14th.

18,227. "Improvements in and pertaining to electric controllers." F. Volk. (Date applied for under Patents Act, 1901, September 12th, 1905, being date of application in United States.) August 14th. (Complete.)

18,229. "Cap for use with telephones." W. P. F. Miller. August 14th.

18,255. "High tension section insulator for electric tramways or railways." F. G. Kleinsteuber. (Date applied for under Patents Act, 1901, August 14th, 1905, being date of application in Germany.) August 14th. (Complete.)

18,278. "Improvements in and relating to electric railway systems." The British Thomson-Houston Co., Ltd. (C. J. Kintner, United States.) August 14th.

18,279. "Improvements in and relating to electric railway systems." The British Thomson-Houston Co., Ltd. (C. J. Kintner, United States.) August 14th.

18,304. "Improvements in means for preventing the breaking of the conducting wires of electric lamps and electric fittings." S. S. Berry. August 15th.

18,329. "Improvements in or relating to electric conductors." J. C. Fuller and G. Fuller. August 15th.

18,343. "Improvements in or relating to the cores of dynamo-electric machines, transformers and the like having ventilating spaces therein." H. A. Mavor and Mavor & Coulson, Ltd. August 15th.

18,365. "Improvements in metallic cases for motor-starters, switches, fuses and the like electrical apparatus." P. S. Brook and J. A. Hirst. August 16th.

18,387. "Automatic clock switch for controlling electric circuits, taps, valves and the like." A. Geall. August 16th.

18,394. "Improvements in internal combustion engines." E. C. Newcomb and H. Edmunds. August 16th.

18,408. "Improvements in insulators for high-tension conductors." H. H. Lake. (G. Semenza, Italy.) August 16th. (Complete.)

18,428. "Improvements in and relating to devices for adjusting or operating from a distance signalling pointers, indicators, contact arms and the like." Deutsche Telephonwerke G.m.b.H. (formerly named Deutsche Telephonwerke R. Stock & Co., G.m.b.H.). (Date applied for under Patents Act, 1901, November 10th, 1905, being date of application in Germany.) August 16th. (Complete.)

18,435. "Improvements in processes for producing electric discharges." H. Pauling. (Date applied for under Patents Act, 1901, August 18th, 1905, being date of application in Germany.) August 16th. (Complete.)

18,445. "Improvements in electric glow lamp-holders specially applicable to metallic conduits." L. M. Waterhouse. August 17th.

18,458. "Improvements in splicing-grips for use in connection with electric tramways, overhead construction and repairing." A. Phipps. August 17th.

18,464. "Improvements in bow trolleys or collectors for electric railways and tramways." Brecknell, Munro & Rogers, Ltd., and E. M. Munro. August 17th.

18,479. "Improvements in and relating to the cooling of electric appliances." Hon. C. A. Parsons. August 17th.

18,485. "Improvements in incandescing bodies for electric lighting and heating purposes." Allgemeine Elektricitats-Ges. (Date applied for under Patents Act, 1901, August 29th, 1905, being date of application in Germany.) August 17th. (Complete.)

18,486. "Improvements in and relating to time and like switches, especially applicable for use with electric metering apparatus." Allgemeine Elektricitats-Ges. (Date applied for under Patents Act, 1901, August 19th, 1905, being date of application in Germany.) August 17th. (Complete.)

18,487. "Improvements in and relating to filaments." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) August 17th.

18,488. "Improvements in and relating to filaments." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) August 17th.

18,490. "Improvements in systems of motor control." The British Thomson-Houston Co., Ltd. (The General Electric Co., United States.) August 17th. (Complete.)

18,516. "Improvements in and relating to starting switches." A. D. Smith. August 18th.

18,524. "Revolving electrode holder." J. W. Collins. August 18th.

18,531. "Improved means for ventilating dynamo-electric machines." Bruce Peebles & Co., Ltd., and J. L. La Cour. August 18th.

18,532. "Improvements in field magnets for dynamo-electric machines." Bruce Peebles & Co., Ltd., and J. L. La Cour. August 18th.

18,561. "Improved electric current indicator." H. G. Prested. August 18th. (Complete.)

18,565. "Improvements relating to secondary batteries or accumulators." E. M. Schneider. August 18th. (Complete.)

18,578. "Improvements in electric clocks and like mechanisms." M. M. McHardy and G. B. Bowell. August 18th.

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1905.

Dynamo-Electric Machines. British Thomson-Houston Co. (General Electric Co., United States.) 15,860. August 2nd.

Equalising Conductors of Dynamo-Electric Machines. British Thomson-Houston Co., Ltd. (General Electric Co., United States.) 15,860A. (Date applied for under Rule 5 of Patents Rules 1905, August 2nd, 1905.)

Enclosed Arc Lamps. E. R. Grote and M. V. Ely. 17,107. August 23rd.

Apparatus for Producing Electrical Discharges. H. J. Haddan. (Synchronous Static Co.) 17,308. August 26th.

Connectors for Electric Cables. E. C. Lea. 18,016. September 6th.

Brush Holders for Dynamo-Electric Machinery. J. H. St. Hill Mawdsley. 19,368. September 25th.

Electrically Operated Displaying Mechanism for Advertisements and the like. H. S. Woodyer and W. E. Woodyer. 20,184. October 5th.

Electric Switches. British Thomson-Houston Co. and E. B. Wedmore. 21,439. October 21st.

Igniting Apparatus for Explosion Engines. M. Pognon. 26,174. December 15th.

1906.

Electrode for Arc Lamps. O. Konitzer. 1,766. January 3rd. (Date applied for under International Convention, January 23rd, 1905.)

Means or Apparatus for Driving and Controlling Electrically Operated Capstans, Hoists and like Hauling and Winding Apparatus. Clarke, Chapman & Co., H. Walker and G. W. Money. 4,318. February 21st.

Apparatus for Regulating the Pressure of Alternating Current Electric Generators. Ganz & Co. Eisengiesserei und Maschinenfabriks Akt.-Ges. 4,657. February 26th. (Date applied for under International Convention, May 24th, 1905.)

Cooling the Commutator of a Dynamo-Electric Machine and Constructing the Commutator Therefor. Siemens Bros. & Co. and C. M. Toplis. 7,255. March 26th.

Synchronising Apparatus for Alternating Current Dynamo-Electric Machines. H. J. McMahan. 7,891. April 2nd. (Date applied for under International Convention, April 10th, 1905.)

Vapour-Electric Apparatus. P. C. Hewitt. 8,612. April 10th. (Date applied for under International Convention, April 25th, 1905.)

Electrode for Storage Batteries. T. A. Edison. 1,924. January 25th. (Date applied for under International Convention, November 2nd, 1905.)

Storage Battery Electrodes. T. A. Edison and J. W. Aylsworth. 1,928. January 25th. (Date applied for under International Convention, April 28th, 1905.)

Manufacture or Treatment of Filaments for Incandescent Electric Lamps. H. Zerning. 2,437. January 31st.

Electric Mixing Furnace for Mixing Steel. Soc. Electro-Metallurgique Frangaise. 3,004. February 7th. (Date applied for under International Convention, February 11th, 1905.)

Regulating Arrangements for Use in Connection with Electro-Mechanical Systems for Propelling Automobiles and the like. H. Pieper. 4,163. February 20th. (Date applied for under International Convention, February 28th, 1905.)

Electro-Magnetic Door-Opening Apparatus. G. Smith and F. Bausche. 4,653. February 26th.

Process for Manufacturing Electric Incandescence Bodies of Difficultly Fusible Conductive Materials and for Uniting such Bodies to Supply Conductors. H. Kuzel. 8,057. April 3rd. (Date applied for under International Convention, August 3rd, 1905.)

Automatic Regulation of Continuous Current Electro-Motors Used for Driving Variably or Intermittently Working Machines such as Rolling Mills and the like. H. Pieper. 9,313. April 20th.

Production of Electric Arc Light and Apparatus Therefor. P. M. Justice. (Phoenix Elektrotechnische Ges.) 2,244. January 29th.

Operating and Controlling Quadruplex Telegraph Systems, also Applicable to other Telegraph Circuits or Systems. T. H. Berry and V. Berry. 3,239. February 9th.

Method and Means for Working Telegraphic Installations Composed of Rapidly and Slowly Working Lines. Siemens & Halske Akt.-Ges. 5,744. March 9th. (Date applied for under International Convention, March 11th, 1905.)

Anti-Vibration Device for Electric Meters and the like. L. Robinson and Co., L. I. Robinson. 6,180. March 14th.

Treatment of Magnetic Materials. R. A. Hadfield. 6,426. March 16th.

Indication at a Distance of Electrical Pressures in the Conductors of Electricity Supply Systems. A. B. Holmes. 6,644. March 20th.

Intercommunication Telephone Systems. I. B. Birnbaum, H. G. White and A. Muller. 6,939. March 22nd.

Electric Brakes. L. Ffingst. 7,416. March 27th.

Rotary Field Magnets for Single-Phase and Polyphase Electric Current Generators. Bergmann-Elektricitats Werke Akt.-Ges. 11,300. May 14th. (Date applied for under International Convention, May 20th, 1905.)

Electrically Heated Stove. Herde und Ofenfabrik Commandit-Ges. F.A.C. Gutjahr & Co. 12,488. May 29th. (Date applied for under International Convention, May 9th, 1906.)

Connection System for Supplying Alternating Currents of Variable Voltage. R. P. Jackson. 12,493. May 29th. (Date applied for under International Convention, June 12th, 1905.)

Continuous or Alternating Current Electrical Machines with Commutating Poles. E. Arnold. 14,712. June 27th. (Date applied for under International Convention, October 20th, 1905.)